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IMPERIAL AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.

Proceedings of the Seventeenth Indian Science Congress

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PROCEEDINGS OF THE SEVENTEENTH INDIAN SCIENCE CONGRESS.

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General.

The seventeenth meeting of the Indian Science Congress was held in Allahabad from January 2nd to the 8th, 1930.

The inaugural meeting was held on Thursday, January 2nd, 1930, at 11 A.M. in the Senate Hall of the University of Allahabad. His Excellency the Governor of the United Provinces of Agra and Oudh welcomed the delegates in a short speech after which the President, Col. S. R. Christophers, delivered his address.

The Sectional Presidential Addresses were delivered as follows:—

Thursday, January 2nd, 2-30 P.M., Agriculture.
Friday, January 3rd, 10 A.M., Botany; 11 A.M., Medical and Veterinary Research; 12 noon, Mathematics and Physics.
Saturday, January 4th, 10 A.M., Zoology; 11 A.M., Anthropology; 12 noon, Psychology.
Monday, January 6th, 10 A.M. Chemistry; 11 A.M., Geology.

The following joint meetings were held:—

Friday, January 3rd, Sections of Agriculture and Botany.
  Subject:—Organisation of Agricultural Research in India.
Saturday, January 4th, Sections of Agriculture and Botany.
  Subject:—Rice and Plant Physiology

The following functions were arranged in connection with the Congress:—

January 2nd, 4 P.M., Rai Bahadur Jagamal Raja "At Home" at 50, George Town, Canning Road.
January 3rd, 2-30 P.M., Visit to the Naini Glass Works.
January 4th, 4 P.M., Mr. Badri Narain (Advocate, High Court) "At Home."
January 5th, whole day excursion to Benares.
January 6th, 2-30 P.M., Visit to the Agricultural Institute, Naini.
  4 P.M., Dr. Sam Higginbottam "At Home" at the Institute.
January 7th, 2-30 P.M. Visit to the Fort.
  3-30 P.M. River Trip.
  4 P.M. The Scientific Institute Company, Ltd., Allahabad, "At Home" on the Jamuna.
  9 P.M. Musical Soiree.

The Popular Lectures were delivered as follows :—

January 2nd, 6 P.M., "Relationship between modern Psychiatry and Law" by Lt.-Col. Owen Berkeley Hill, I.M.S.

January 3rd, 6 P.M., "Kala-azar" by Dr. U. N. Brahmachari, M.D.

January 4th, 6 P.M., "Prevention of Cattle diseases as a factor in the agricultural prosperity of India" by Prof. V. Krishnamurthy Ayyar, G.M.V.C., I.V.S.

January 6th, 6-30 P.M., "New ideas on the Electron" by Prof. Dr. M. N. Saha, F.R.S.

The Council of the Indian Science Congress met on the 3rd January.

The Executive Committee met on the 4th January.

The General Committee met on the 7th January.

Opening Proceedings.

The seventeenth session of the Indian Science Congress was opened on Thursday, January 2nd, 1930, at 11 A.M. by His Excellency Sir William Malcolm Hailey, G.C.I.E., K.C.S.I., I.C.S., Governor of the United Provinces of Agra and Oudh, the Patron of the Congress, at the Senate Hall, Allahabad University, in the presence of a large gathering of delegates and visitors. A large number of ladies were also present.

In declaring the Congress open, H. E. the Governor spoke as follows:—

> "I think that in anything which I say, I should properly limit myself to welcoming to the United Provinces the many distinguished scientists whom your Congress has called together to-day and to the expression of a hope that your stay at Allahabad may be as pleasant to you as I know that it will be profitable to us. That is a simple task well within a layman's capacity, and one which I can—and do—discharge with all sincerity. In doing so, I can speak on behalf of an ever-growing band of scholars interested in the sciences of which you are masters; for nothing is more noticeable to those who are conversant with the work of our universities, than the increasing attraction which the study of science possesses for their students, nor the pride they display when the outside world gives its recognition to those who work in their laboratories. But further, I can speak also on behalf of a public which shows a growing appreciation of all that Applied Science can do for its welfare and its progress. We have, for instance, definitely passed the day when the agriculturalist resents the suggestion that research can add anything to the traditions which he has inherited from his forefathers, or that modern science can throw new light on the methods by which he has fought a stubborn and capricious nature, in the effort to win subsistence from his fields. In several places, Aristotle lays stress on the difference between those whom he calls "theologians" who treat science under the form of myth, and the "philosophers" or "physiologists" who set forth their case in a demonstrative form. The agriculturalist no longer pins his faith entirely to the mythology of agriculture; if the physiologist can demonstrate, he will accept his results. We can have no better proof of this than the astonishing expansion during the last few years of the area under improved types of sugar-cane in this Province, yielding a vastly increased outturn to the cultivator. I once asked

the manager of an agricultural farm if there were any difficulty in proving to cultivators the value of an improved type of seed. "None," he said, "if they think a new type of seed is really good, they come in at once and steal it". That exhibits at all events an advance of the scientific if not of the moral spirit. Again, the history of our public health efforts shows an increasing appreciation of what can be effected by scientists in another field; we have daily proofs of the breakdown of the old prejudice against the use of the means which bacteriologists have placed at our disposal for fighting the scourge of cholera, plague, and malaria. May I extend here to-day in particular a welcome to your distinguished President, whose work in this field has secured a world-wide reputation? Again, our recent extension of the hydro-electric supply from the Ganges Canal has been readily welcomed as offering the possibility of irrigation from tube-wells over a wide area now inaccessible to the canal itself. Much of the work of this class fails perhaps to fall within the realm of pure science; but whatever may be the popular feeling on the subject, we are not ourselves now accustomed, nor are we justified, in drawing a definite line of demarcation between pure and applied science, or between investigation and its practical results. You will, at all events, pardon this commonplace statement of our general appreciation from one who, with the ignorance of science which characterized most of his own generation, can yet look with equal amazement on its processes, and gratitude on its achievements. Further than that, I should not have the courage to venture on such an occasion as this, fearing lest an incursion into unfamiliar fields might bring me that terrible condemnation of which the Persian poet speaks—"The applause of the ignorant and the silence of the learned". But perhaps I may find justification for one general suggestion. To those who associate with the workers in our universities, there often appears at present to be a certain wastage of effort in some types of scientific work. One is not so ignorant as to suggest that research should be or can be directed entirely to the service of our every day problems or our current needs. Research must range over the widest possible field; in one sense, no genuine piece of research work can be said to be wasted, whatever its object or its conclusion, since every definite intellectual effort must have its reaction in increasing the world's mental activity Whether the particular effort makes what is generally known as a positive contribution to science will often depend on circumstances, and notably on the need felt at the moment by workers in one branch of science to utilize the results of inquiries made in other directions.

The studies of a somewhat obscure Greek philosopher into the theory of curves were apparently condemned to remain unnoticed and unused for many centuries until Kepler found he needed them to establish the laws governing the elliptical orbits of the planets. Even the most unscientific mind now knows that research is bound to present the appearance of a continuous series of journeys down side paths which for a time seem to have no ending and no connexion with the main roads which are shown on the map of science as recording its positive achievements. An infinite number of such side excursions do actually lead nowhere; but we never know whether in due season some one of them may not be found to link up with the path trodden by other inquiries, and to constitute an avenue to the discovery of a natural law or a new conquest of the human mind over the forces of nature. But recognizing all this, I would still ask whether some more conscious co-ordination among research workers in our universities is not possible, as an aid to those who are engaged in attempting solutions of practical problems affecting our every day needs. I do not complain that our universities have devoted themselves so widely to what we generally know as arts subjects, to the almost total exclusion of technological education. In the first place, no layman ever dare have the temerity to complain of what a university chooses to do; in the second, there were probably financial reasons which have stood in their way. But surely many of the needs of our Agricultural Department for research work could be met by the workers in our universities, and again the efforts of university workers could surely be definitely directed to meet some of the botanical and entomological needs of our Forest Institute. What contribution have our university workers made to the study of the hydraulic problems of our irrigation engineers? Could any of our university entomologists tell us anything of first-rate value about the life history of our recent and most unwelcome guest, the locust? Have the physicists or the chemists tried to give us a comprehensive and systematic soil survey of the province? Certainly, our economists only seem to be recently awakening to the need of turning their attention to a practical study of the economic facts of the province; one would have expected that with large schools of economics in each of our universities, we should have found ready to hand most of the material which the Banking Committee is setting itself to collect. Now I am well aware that there are definite limits to the extent to which the efforts of our research workers or students can be directed to these problems; and I am also well aware that co-ordination of their labours cannot be directed from outside. It must be voluntary effort, or at the most, it must be advice given by some Academy of Science which will contain authoritative representatives of all the specialized branches of scientific activity now at work in the province. But if some form of visible co-ordination could be attempted, and if it could be proved to the public that science workers were contributing some at least of their energies in the direction I have suggested, then I believe that we should have a far more effective case in calling for that public support and private liberality on which the further progress of scientific work must depend. You could, I think, touch public imagination on a new side; and you must touch its imagination before you can effectively appeal for its aid. I have argued as though this co-operative effort would mainly provide assistance to some of those who are labourers in definitely practical fields of work. But I have no such restricted end in view. I believe that closer union, if it could be achieved, would, by making an effective appeal to the public, in turn secure provision for an extension of scientific work at large. If so, we shall have achieved far more than a ready means of assisting to a solution of some of our provincial problems. We shall have made it possible to add fresh names to that band of workers which is securing for India a new position and a new reputation among the nations. It is for this generation to attempt and it should be its pride to secure for her in the modern world of science a name which will eclipse that which her contributions to philosophy and religion brought her in the ages that are past."

After the opening of the Congress the President delivered his Presidential Address.

Presidential Address.

Congress President :—COL. S. R. CHRISTOPHERS, C.I.E., O.B.E., K.H.P., F.R.S., I.M.S., F.A.S.B.

THE SCIENCE OF DISEASE.

YOUR EXCELLENCY, LADIES AND GENTLEMEN,

Before coming to the subject proper of my discourse today I have the pleasant duty to perform of welcoming all of you here to the 17th Meeting of the Indian Science Congress. Unlike some Scientific Congresses that have been held in India the Indian Science Congress is in inception and scope one intended primarily for India's own scientific workers. It is therefore worthy of our fullest support and of our efforts to make it as great a success as possible. I need hardly point out the high position India has taken in many scientific subjects. In Physics, Chemistry, Zoology, Botany, Geology, Agricultural Science, Meteorology, Medical Research, and other branches of Science Indian workers have added considerably to the sum total of the accomplishments of Science and I feel very deeply the honour of addressing this audience in which a number of those who have taken part in this work are present.

I found myself at first in some little difficulty to decide upon a subject that would be appropriate. It seemed most natural to speak on some medical research subject with which I was specially conversant. But this was perhaps too restricted a view to take for such a gathering as the present in which all sciences are represented and I sought for some general question that might interest you. Yet when I began to venture into realms that were not my own I felt a certain trepidation, since specialization now makes it very difficult for an ordinary person to speak without danger of tripping in any subject but his own. Eventually I decided not to roam too far, untrammelled by that strictly professional knowledge which many of you here possess in your own subject and, still within the safe bounds of my own general territory, to give you a brief sketch of the nature of the field covered by Medical Research, or as I prefer to it here the Science of Disease. Coming as Medical Research does into close relationship with many sciences each of you may possibly be interested in at least some part of my remarks. I was the more supported in my choice when I remembered that there is a general interest taken in matters of health and disease and that, perhaps if I failed to interest you as experts in your own particular science, I might still possibly approach you on a subject of general public importance and interest.

At the bottom of all questions of health, of curative or preventive Medicine, or of Medical Art lies the necessity of knowledge of the causes of disease. The Science of Disease is therefore the very root of Medical Research. We cannot know what is required to maintain health until we know what may cause departure from this and we cannot usually cure or prevent without knowing how diseases are caused. It is because just this knowledge, so simple when attained, so overlain in incredible secrecy until so attained, is so difficult and precious to come by, that medicine has had such an uphill fight. It has been both Medicine's trial and honour that the subject it has had to deal with is not simple and straight-forward but bound up with what, even in this present day, are among the most advanced developments of science. Its chemistry as we now realise is mainly colloidal chemistry since living matter consists of colloids, its biology lies in the subtlest regions of parasitology and the hosts reaction to invasion, its physics deals with the electric charge of proteins and such like things.

Just as Astronomy is the science of the stars, Biology the science of living things and Seismology the science of earthquakes, and so on, there is clearly a science of Disease, though curiously enough it seems to have no name. Nor is this science unimportant or merely altogether the application of other sciences. It has its own field, its own techniques, and its own extensions into high matters which cannot strictly be put under chemistry or biology any more than can astronomy be usefully considered as merely physics.

I propose then briefly to indicate the role of this Science, including its practical importance to mankind, to give a very brief history of its growth and development, to describe some of the features of its modern progress that have especially so far seemed to lead to advance and, lastly, I shall go on to some lines of development in which medical research has advanced into fields which are peculiarly its own and in which, though its methods are, as they must be, those of the sciences physics, chemistry, biology and the like, it would appear to have trodden new or unexpected ground.

THE ROLE OF MEDICAL RESEARCH.

The enormous practical utility in human life of a knowledge of the cause of disease is undoubted. It is often said of progress in an individual career "What serves it if a man gains the world and loses his own soul". A somewhat parallel case could be made regarding the enormous advances that have been made in human progress depending upon mechanical and other sciences. Without the means to control disease humanity lies helpless and open to attack. The conquering hero dies of cancer, the powerful emperor is sick of a fever. Disease is the most remorseless, the most cruel, the most continuous in its action of any of the great physical ills that threaten and control mankind Of the three great terrors Sword, Famine and Pestilence, Pestilence, if we mean by this disease, has easily first place. War, at least now, in any given country is temporary, Famine is episodic, but Disease is ever present.

This may sound an exaggeration, but probably few but medical men fully realise the terribleness and cruelty of disease. Insanity, ulcers, pain, blindness, deformations, it is all misery. It is often the fashion with those who do not see much of real disease, as for example that curious body the Christian Scientists, to speak of disease as though it were a merely something a little irregular, a lapse in mental health. But though this may be the view of the fortunately healthy it is not the picture seen by those whose business brings them into close contact with real disease. It would be a terrible thing if the boon of anaesthetics, the reliefs of surgical and medical treatment had never been developed as they are now. Further to disregard the individual and think of disease as affecting communities it is easy to picture what forces of disorder and death might at any time make their appearance, populations ravaged by plague and ignorant of its cause, civilizations destroyed by malaria and knowing not whence it came, men marching athwart the prevailing wind to escape cholera which they carried with them as used to be done. All such thoughts show what a *necessary* science is the one we are discussing. But for many, many centuries the necessity was seen, but this did not help knowledge.

THE HISTORY OF MEDICINE.

The history of our science, if in these early days one could call it a science at all, takes us back a long way. Reference to medical subjects occur in the Vedas at a date estimated to be as early as 1500 B.C. Singer draws attention to an early Egyptian medical papyrus of about 1700 B.C. There are also Mesopotamian and Minoan origins. It is usual to commence the story of Medicine with Hippocrates. Hippocrates was a Greek physician born in the Island of Kos off the shore of Asia Minor. But the source from which knowledge of Hippocratic teaching is derived is the so-called Hippocratic Collection, about 100 books by different authors belonging to different schools and periods dating from about the 6th to the 4th centuries B.C.

The Hippocratic school taught that the body possesses four humours, the blood, phlegm, yellow bile, and black bile, a right proportion of which constitutes health and an improper or irregular distribution disease. About the real causes of disease one is safe to say nothing was known. It should not surprise us that the Hippocratic school, or indeed any ancient system, did not penetrate far the real portals of the causation of disease. For 2000 years afterwards no further progress in knowledge was made and indeed there was for a long time retrogression. So much so that when with the revival of learning in Europe the authentic text of the old Greek practitioners of the Hippocratic school was made available these ancient writings had a very great effect in revivifying the study and practice of medicine. The humoral theory of the Hippocratic school had as much to be said for it and as little to be said against it in the 16th century A.D. as in the time of Hippocrates.

A great name in the history of Medicine was Galen (130–200 A.D.). Galen developed the idea of Pneuma (spirit) penetrating all parts of the body and mingling with the "humours" in different proportions. He held the theory of "temperaments". The normal condition or temperament of the body depended upon a proper mixture or proportion of the four elements—hot, cold, wet, and dry. At this time it was believed that combinations of these elements produced the visable universe, *i.e.*, hot and wet made air, hot and dry fire, dry and cold earth, and so on. In drugs were to be recognised the same elemental qualities, hot, cold, moist, and dry, etc., and so came indications for their use. Galen's explanations and system passed down through the ages as accepted facts. Throughout the middle ages beliefs about physiology and hence disease were always based on Galen. A thousand years later men hesitated before they contradicted even some detail of Galen's dicta. The views of this authority were not the truth but he had a logical mind and he unfortunately explained things so well that everyone was satisfied. One wonders how much we may sometimes be doing the same thing at the present time.

Arabian medicine, *i.e.*, the medicine which arose in the chief seats of the Moslem power in the Mahommedan Empire was a return in a sense to the old Hippocratian medicine for the writings of importance are chiefly based on translations of Greek books into Arabic carried out under the Abbasid Caliphs at Baghdad. The Caliphs were enthusiastically attached to ancient learning, especially the Greek. They collected manuscripts and had these translated by the most competent scholars they could attract to their court. Actual advance made was chiefly in the form of pharmacy and therapeutic uses of drugs. Islamic medicine was the medicine of Europe in the middle ages and remained so till replaced by other systems based again on the old Hippocratian and Galenian systems.

Science which had its beginnings in the 17th century was sometime before it effectively assisted medicine. Looking first for the somewhat simple types of explanation to which it had grown accustomed, it rather tended to create more fallacies of the old type than real progress. Even when anatomy and physiology, mechanics, chemistry, and the like had progressed some distance they had little real help to offer the difficult, intricate, and complicated issues which, had they known it, were necessary to be dealt with in the science of disease. Even in the 18th century strange "systems" prevailed. The Brunonian system explained the processes of life and disease as due to the property of "excitability" in virtue of which the "exciting powers" called forth the vital phenomena of "sense, motion, mental function, and passion". All exciting powers are stimulant. So diseases were recognised as sthenic or asthenic, the latter requiring stimulant treatment, the former sedative. Another system which arose in this time was that of Hahnemann, generally known as Homeopathy, a name one is still familiar with.

It is with relief that one turns from all the endless machinations of the introverted human mind in these early times to the beginning of real progress based on scientific method. It would take too long to follow step by step what now happened in decades where previously one has been dealing with centuries, if not millenia. I must merely indicate a few or some of the major advances made when Science at last entered the field.

Up to this we should remember that until the end of the 18th century no one knew that there was such a material thing as Oxygen. No one up to the middle of the 19th century knew really anything of the microbic origin of disease, though as often happens a sort of theoretical deduction had been put forward in advance of actual knowledge. A Veronese physician, Frascatoro, held a theory which must at least be considered correct so far as it went *viz.*, a rational theory of infection in which he hypothecated minute bodies with the power of self multiplication.

In 1615, Harvey discovered the circulation of the blood. About 1650 a way was found of constructing and mounting simple lenses of high power. In 1661, Malpighi by the aid of such lenses discovered the capillaries. In 1761, Auenbrugger introduced the stethoscope and Laennec (1781–1826) developed the application of so-called physical signs in medicine. In 1796, Jenner showed the protection given by cowpox against smallpox and opened up the subject of Immunity. Schwann (1839) and others showed the cellular nature of animal tissues and laid the first foundation of histology, cytology, and much else. Pasteur (1822–9) laid the foundations of bacteriology and Lister (1861) of aseptic surgery Anæsthesia came into surgery in 1846 with the use of ether by Morton and (1847) chloroform by Simpson. In 1876, Koch demonstrated the microbic causation of many diseases and began the study of disease causing organisms as things which could be seen, described, and grown.

Taking 1518, the date of the death of Leonardo di Vinci, who was the first to question the views of Galen as the very beginning of the new order of things, we have by 1880 or in about 250 years progressed from the stagnation of two millenia and the unchallenged supremacy of Hippocratean medicine of 300 B.C practically into present day conditions, where in theory and execution medicine has become one of the greatest, though still almost, if not quite, the most complicated and difficult of all sciences.

FEATURES OF MODERN PROGRESS.

So far the underlying note had almost always been " cure ". Early medicine was concerned primarily and almost single-mindedly with cure. With many even at the present day the idea of cure as the role of medicine predominates. It is only relatively recently that the importance of prevention in the individual and in humanity in the mass has come forward.

Another feature of modern and especially of preventive medicine that is called to mind by the discussion of the predominance of the immediate utilitarian idea of cure is what is very aptly put by Singer in his short history of medicine as the recognition of the " fallacy of the frontal attack ". Many would have us picture as the highest ideal that of the worker who sets out to obtain a cure for some terrible disease. This would no doubt be a very worthy and high motive, but it is doubtful if to the world at large it is likely to be as effective as the perhaps more selfish but in the end more productive following of science for its own sake. Medicine, still an art, advances only on a basis of science. Its votaries and certainly its scientific staff would be wise to bear in mind one of the peculiarities of science, *viz.*, that from apparently the most seemingly and almost apparently trivial discoveries have come the greatest benefits. Koch would never have seen the tubercle bacillus, nor indeed any of us, if men from the love of science for its own sake had not engaged themselves in those, what must have seemed in those times trivial, studies that resulted in the creation of the modern microscope, without which it is I think legitimate to say that no science of disease could ever have originated. Hence in the modern development of medical research the field must be wide, curiosity, that trait in human character which is the most powerful opener of secrets and apparently the key to the dominion of man over nature, must point the way. This again raises issues which I do not propose to enter into here, which are nevertheless very important in the question of Medical Research Administration.

The time which I can expect you to give me is limited and I must pass somewhat more rapidly if I am to cover the ground intended.

As Col. Mackie has said in his excellent resume of Medical

Research in India [1], in Medicine men at first depended on the unaided senses and such clinical and epidemiological observations as could be made without any very special outside help. With the microscope and delicate chemical and other tests there evolved the pathologist, bacteriologists, protozoologist, biochemist, parasitologist, entomologist, and so on. This specialization is becoming increasingly inevitable and its degree more pronounced owing to the vast field which even a single one of these sciences embraces.

The evolution of medical research has followed these lines in all parts of the world but nowhere so remarkably as in the tropics where disease like vegetation flourishes in some sort of relation to temperature. The greatest outstanding feature in tropical medicine is perhaps the enormous advance in parasitology and the transmission of parasitological disease. All this advance has been for the most part very recent, in what may almost be called the Recent or Holocene Period, of our subject,—speaking geologically, which may be said to start from the electrifiying discovery by Ross that that age long mystery, the method of entry into the human body of the parasite of malaria, was after all only a special case of Heteroxeny, by a parasite belonging to the Class Sporozoa.

So enormous has been the development in Tropical Medicine in the 30 years that have elapsed since that epoch-making discovery that it is quite impracticable for me to sketch even in outline what has been achieved in any detail. I shall do better to consider in broad outline what has been the general effect of this advance on our special science, the science of disease.

To those actually concerned with the prevention of disease nothing becomes clearer than that any effective action against a disease is almost absolutely dependent on the knowledge of the means of causation. A good example is Plague. Formerly plague was viewed in the light of a directly infectious disease. Thus sanitary cordons and such like measures were those first enforced. When the idea of microbic infection had gained ground indiscriminate disinfection was added How many thousands of gallons of disinfectant, often quite unsuitable to destroy *insect* life, must not have been thrown broadcast killing only harmless saprophytes while real infection lurked in the living rats and fleas in safe retreat. To a demon it must have appeared like some grim game of blindman's buff, men seeking to destroy by blind indiscriminate ineffective action what, if they could have seen, they could have picked out selectively for elimination. A human case of bubonic plague we now know is comparatively harmless, the real danger lines in the epizootic conditions that infect the area and hence evacuation rather than cordons and disinfectants to destroy fleas rather than microbes, usually a different kind of chemical altogether, are the proper things to use, and further and more fundamentally, we know there should not be such habitations as are suitable to infestation by rats or places that grain are kept that are not rat proof and so on. The same exactly has been the case with malaria. People believed they were inhaling miasm, all nature as it were exhaling a poison, when in reality the source was concrete a little fragile mosquito that individually could be crushed with ease and against which any individual with reasonable care can completely protect himself. We do not fear malaria now when we are in the primeval swamp, but when we come to our camp amongst other humans who have the disease.

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[1] Souvenir. The Indian Empire. 7th F.E.A.T.M. Congress, 1927.

Further it is not enough to know only the broad fact of how a disease is transmitted. We must know every detail in such transmission. We must know intimately the life histories of mosquitoes, fleas, lice, and other insects, the resistance of organisms to desiccation, to chemical substances, and so on. We must know not only that some disease is due to faulty diet, for not all diseases are transmitted, but we must know with exactness the chemical and other characters that are lacking.

We now know pretty effectively the causation and details of transmission of Plague, Malaria, Filariasis, Typhus, Relapsing fever, Beri-beri, Leprosy, Enteric, Hookworn anaemia, Schistosomiasis, and numerous other diseases.

RELATION OF MEDICAL RESEARCH TO OTHER SCIENCES.

All this has not come about without a great deal of drawing upon sources outside medical research proper, if we think of this as purely medical work, nor has it all been done by medical men though these have done a major share. Many workers in medical research are chemists, many not only use biological methods but are to all intents and purposes biologists. Specialization may in present times be considered unfortunate, but it is only fair to say that in this way only can the worker in one line get what he wants when he has to rely upon the services of another. It is often the fashion to make disparaging remarks about the dry as dust systematist, the man who counts the very hairs on an insects tail, yet scarcely a move can be made without his tremendous knowledge of details in his own sphere, more and more the technique and methods of entomology, helminthology, protozoology, bacteriology, colloidal and physical chemistry, and other sciences are found necessary

Medical research dealing as it does with departure from the normal conditions of the body has obviously a relation to Physiology. Largely through the effects seen in disease has come our knowledge of the functions of the ductless glands and the part played in the physiology of the body by the secretions of these glands or hormones. Again in nutrition it is largely studies directed against disease which have made us familiar with the effect of the vitamins and of radiation in the maintenance of the normal functions of nutrition.

With Biology medical research is very closely associated. The fact that many diseases are due to parasites has led to very close study by medical research workers of groups of organisms that otherwise might not have received such minute attention. The science of Bacteriology which deals with a whole range of organisms, which we now know to play a tremendous role in nature, arose largely in the beginning from a study of the causes of disease and this science, in one sense a branch of biology, is still very largely dealt with by medical science. The same with the protozoa, especially the great parasitic groups sporozoa and flagellata. The life histories of some of these, puzzles that have taken endless work to unravel, would scarcely have been revealed to us had their activities not brought them into the field of medical research and so focussed upon them a specially intense effort. Even with higher parasites, *e.g.*, the worms, Science would have been poorer without the results of the patient and difficult studies which have revealed to what degree of complexity parasitism may proceed. The development of filaria in the mosquito, of dracunculus in the water-flea, of schistosoma in the snail are examples. In Entomology certain groups, like the mosquitoes, have almost been a preserve in the hands of medical workers or those who work at them knowing the great medical interest taken in this group.

The modern investigation of drugs and especially the search for effective therapeutic compounds of mercury, arsenic, and antimony has added considerably to the stimulation of chemists in these subjects. Even more has the close association of the processes of health and disease with colloidal chemistry brought medical research activities into the higher realms of chemical research. A vast literature on immunology, really a study of complicated protein reactions, comes strictly perhaps almost under physical chemistry, though the techniques and chief results have been carried out in connection with the study of disease.

Nor is Physics immune from the encroachments of the nameless science we are discussing. Questions of the electri charge borne by colloidal particles, adsorption and surfac tension phenomena, and much else has been increasingly familiar in medical research laboratories in recent years.

SOME SPECIAL DEVELOPMENTS.

But the contributions to Science of medical research, though they must naturally in a sense fall within the limits of Physics, Chemistry or Biology, are not always merely applications of these sciences or subordinate additions to their findings. With a mention of some recent examples of such a kind space now demands that I should bring my remarks to a close.

First, I will take the very interesting subject of Bacteriophage and the biological issues raised by this. From about 1917 a series of communications by D'Herelle clearly set forth the discovery of an entirely new phenomenon, in which the essential feature was the apparent eating up, or more strictly the solution, of the bodies of various kinds of bacteria under the influence of an invisible "enemy". D'Herelle was working at the bacteriology of the contents of the alimentary canal of locusts, seeking in fact for a virulent organism capable of being used in the destruction of these insects. When making plates in the usual way for the isolation of organisms it frequently happened that clear spaces were evident in the opaque growth of the bacteria under investigation. These spots, it was eventually clear, were the result of the activity of some invisible agency, which dissolved the bodies of the bacteria. Under the microscope when the process was in action one could see a vacuole appear in the substance of a bacterium which increased in size, and if others were present coalesced with these, until suddenly the minute bacterial body underwent complete dissolution. Transferring material from a clear spot to an unaffected area on the plate caused the phenomenon to repeat itself.

Not only was the principle causing this solution of bacterial substance invisible, but it was found to be capable of passing readily through the pores of a Pasteur Chamberland filter, a fact that showed that it was far more minute than the organisms with which it was associated. Further this principle was capable of indefinite self-propagation. If to a tube of culture a little of this principle was added the bacteria which cause the nutrient fluid medium to be turbid were dissolved with the result that the medium then became quite clear. If a tiny drop, or fraction of a drop, from such a cleared tube were added to a fresh culture this also was cleared and such a process could be repeated for as many transplantations as one wished, the enormous dilution involved after a time making it quite clear that the principle, whatever it was, was reproducing itself actively in every tube. Evidently the principle had one very important character which we are accustomed to think of as proper to Life, *viz*, it was capable of indefinite self-propagation so long as there was "food" for it to work upon.

Though invisible it was possible to show that this principle was particulate and indeed it is now quite well known that it is of the nature of a protein colloidal particle. The phenomenon is called by D'Herelle bacteriophagy and the particulate cause "bacteriophage".

Now is this principle alive? Hitherto biologists have dealt with life as tantamount to properties exhibited by the "cell".

Always it is protoplasm, usually with a nucleus, which is supposed to be alive. In the bacteriophage we have something clearly very near a living thing which is clearly not a cell, nor is it protoplasm. I am not here to-night to say whether the bacteriophage particle represents life or not, but you will agree with me that here medical research has brought into the workshop of science something that can be easily investigated and which must be of supreme interest to the biologist.

D'Herelle believes that natural cure in disease results when the bacteriophage in nature overcomes the infecting organism. All the immunological processes medical research has dealt within such vast but confusing thoroughness he admits only as accessory phenomena, mere necessities of colloidal phases. What the practical importance of bacteriophage may be none can yet say. Even if it should have no direct bearing on the prevention of disease, which is unlikely, it is a new line of investigation into most fundmental regions of colloidal chemistry and biology and who can say at this early stage where it may lead.

But the bacteriophage does not stand alone. It has close relationships with the so-called Filterable Viruses. When the microbic origin of many diseases had been demonstrated it was natural to believe that all infectious diseases must be due to some form of organism even if one had failed to demonstrate this. And a certain number of diseases have eventually fallen under the microbic category though they for a time resisted the search for a causative microbe. But many have resisted every attempt and some of these are amongst the most deadly of diseases known, *e.g.*, small-pox, rabies or hydrophobia, and yellow fever. In many such cases, it is now recognised that infection will pass through the Pasteur Chamberland filter and so it is probable that the causative organism, if it is an organism, has not been seen because it is too small for visibility. Further infection is not thought to be the result of an organism in the accepted sense, *i.e.*, minute cells as the bacteria and protozoa all are, but to be probably of the nature of protein colloidal particles and for this reason they are known as "Viruses". Indeed, the bacteriophage seems to be only a special form of an entirely new type of living thing, *i.e.*, if we are prepared to define life as ordinarily understood, and certainly small-pox, for example, if it is not due to a living thing is remarkably similar in its natural history to other diseases that are.

Yet if these viruses are living things they are something almost if not quite as far below the bacteria in size as these are below living things visible to the naked eye. And on account of their size they are subject to influences which do not affect the relatively large bacteria or protozoa. Bacteriophage, for example, when first added to a bacterial culture disappears entirely from the fluid medium to appear only later when the bacteria are breaking down. In other words, it appears to be subject to adsorption which not even the smallest bacterium is.

There still remain diseases as outstanding puzzles as ever any disease has been, I need mention only cancer, and medical research, nameless as a science though it is, may yet strike many things in its own proper sphere which are of great importance in the general advance of science.

Section of Agriculture.

President:—G. CLARKE. C.I.E., F.I.C., M.L.C.

Presidential Address.

"SOME ASPECTS OF SOIL IMPROVEMENT IN RELATION TO CROP PRODUCTION."

I ask your permission to direct your attention to some aspects of soil improvement in relation to crop production. I propose to pass in brief review some of our problems and then to touch on the work to which my colleagues, Khan Sahib Sheikh Mohommad Naib Husain, Rai Sahib S. C. Banerjee, and myself have devoted a number of years at the Shahjahanpur Research Station. My subject is directly connected with the supply of the first necessity of life, namely, food. By what methods is the world going to continue to feed its growing population ? It is increasing at the rate of nearly 20 millions a year, and it cannot be suddenly checked. Can food be found for all these extra mouths, or will the pressure on our land resources become unbearable, and end in disaster ? That is the collossal problem facing the world in the next few generations. It must be met either by a continual expansion of cultivation, or an intensification of production on land already cultivated.

How do we stand in India in respect to these questions ? I have proceeded in a somewhat empirical fashion to ascertain the relation between population and arable land. I have selected, in making my estimate, the figures used in International statistics, the total area sown and the current fallows. I have deducted the area required for the production of exported cotton, foodgrains, oilseeds, jute, and tea which account for about 80 per cent. of the value of our exports. This estimate is admittedly rough and must be regarded as suggestive rather than as an exact measure, but it is sufficiently near to illustrate my point.

I have taken the year 1922–23 following the census year 1921, and the year 1925–26. In 1922–23 the total area sown in that part of India for which agricultural returns are made was 327 million acres, 61 were under fallow, making a total of 388 million acres. From this may be deducted as producing exported material for cotton 14, for foodgrains 9, for oilseeds 5, for jute 2, for tea 0.6 million acres, or 31 million acres in round numbers. So that 357 million acres are left to supply the requirements in home produced food and other essential commodities of the 292 million people who live in the territory covered by these figures, *viz.*, 1.2 acres per unit population.

A similar calculation for 1925–26 gives the same result. I have selected for a summary comparison the United States of America, and France, two countries possessing points of resemblance to India. In both, as in India, agriculture is of predominant importance. In the United States 356 million acres are in cultivation. 65 million producing exported material may be deducted from this, leaving 291 million acres of cultivated land devoted to supplying a population of approximately 112 million, or 2.6 acres per unit of population. The dominant characteristic of American economic life has hitherto been abundance of land resources. France, a country which is largely self-supporting, has 36.3 million hectares of cultivated land for a population of 39 3 million, approximately 2.3 acres for each head of the population.

In considering these figures we have to allow for the fact that the vegetarian diet adopted by our people is more economical of the resources of the soil than the diet of the people of the United States and France. Living is cheap in India, but when all has been said that can be said, we are left with the plain fact before us that we have one half the area of cultivated land for a unit of population.

The past experience of the world shows that as long as new land of the necessary quality is available, increased food will be obtained less by increased skill and expenditure on old land than by taking up new land. Our map has shown for several decades well over a hundred million acres in the British Provinces of India classified as culturable waste. Why is not new land coming into cultivation ? I cannot give a complete answer. No such process can be observed in steady operation on a scale sufficient to raise the *per capita* area of cultivation to a level which will meet our food requirements. Some recent settlements in this province show an increase in cultivation of only 1 to 3 per cent. in 30 years, while in others the area is stationary. For a number of reasons the area of culturable waste gives an unreal conception of our resources. Much of the land thus classified includes areas physically capable of being employed for crops only when our need is so extreme that considerations of cost of utilization are relatively secondary. Fifty per cent. we know is situated in Burma and Assam, out of the sphere of action of our chief agricultural races. A great deal is in Tarai tracts where health reasons prevent extensive settlement. Land is coming under the plough, to some extent, in the villages of the Sarda canal area in these provinces, and will do so elsewhere as irrigation schemes mature, but in India, as in other parts of the world, new land of the necessary quality for food crops is no longer easy to find.

This brings me to the first part of my argument—the necessity of increasing the acre yield of land now under the plough if an ample supply of food and the home grown necessaries of life is to be assured to the Indian worker, and his standard of living raised above subsistence level. It is a difficult problem but it is not insoluble.

When I considered this matter some months ago, I asked myself three questions :—

(1) What factors are in our favour, and what are against us, when we begin to intensify our cultivation ?

(2) Will the knowledge and experience of other countries help to accelerate our progress ? What new knowledge do we need ?

(3) What is the quantitative measure of the result we may expect ?

I propose to give you the answers that suggested themselves to me, based on conditions in these provinces where my experience has been gained.

We have in our favour two things. In the first place, soil that is easy to manage and quickly responds to treatment, and secondly agricultural workers attached to their calling and possessing a strongly developed land sense which, by some curious twist in our make up, can only be acquired in childhood. We shall not come up against a shortage of agricultural workers of the kind that is hindering development in Australia and Canada. In these countries, a high degree of skill has to be directed to economy of labour by the use of machinery and labour saving devices. In India, our efforts will have to be devoted to economising land. We are better placed than most countries as regards the primary essential for increasing production per unit of land, namely, man power. You may ask me, "What is delaying our progress with two such assets ?" This opens up a wide sociological study. I believe ignorance and a larger share of ill-health than should fall to the lot of an average being play a part. The stimulus required seems to be education of a rural type. I cannot, however, pursue this issue, and return to my agricultural text.

We have to contend against difficult weather conditions and short growing seasons requiring early maturing and specialised varieties of crops. The Howards, in the "Development of Indian Agriculture", describe graphically the effect of the monsoon on the soil and on the people. It is indeed the dominant factor in rural India.

We shall always at intervals experience years of short rainfall and this fact gives additional force to my argument for increasing the acre yield in favourable seasons by improved soil management if we are to avoid starvation. Much has been done to intensify yields without any commensurate increase of labour on soil improvement by the introduction of more heavily cropping varieties. I need only quote as examples wheat and cotton in the Punjab and wheat and sugar-cane in the United

Provinces, which are adding crores to the cultivators' income. Indian conditions, however, test the skill of the plant breeder very severely and further steps in improvement in this direction are not going to be easily won.

I now pass on to that part of my subject which has greater interest for a scientific audience than some of the stubborn facts I have placed before you. I mean the consideration of some aspects of recent work on soil improvement and the lines on which enquiry may be directed in India.

Since Boussingault introduced the method of exact field experiment in 1834, research on the soil and the conditions of crop growth has been continuous in Europe and America. The methods of approach have become more exact with each advance in pure science. We, therefore, start our work on soil improvement in India with tools ready made. Investigations carried out in other countries have given us the principles involved and often the technique of methods of research. Our work for the moment is to apply them to conditions where soil processes differ widely both in intensity and time of occurrence, from those of temperate climates. I have been impressed by the desirability of applying to our problems a conception developed in recent years by the Cambridge and Rothamsted workers, which has given a new and wider significance to the field experiment. The final yield gives us no indication of what happens during the plant's life or how it responds to factors operating at successive stages of growth. The modern method makes quantitative observations of crops throughout the period of growth and examines the results by statistical methods. This is nothing more than reducing to exact measurement and scientific treatment the observations which every practical farmer makes but does not formulate. The advantage is obvious. Information covering a wider range than the old type of field experiment can be obtained in a few years, instead of taking generations. You will remember that Lawes and Gilbert waited twenty years before discussing the results of their experiments. The field experiment lasting twenty or more years no longer fulfils our requirements. We want results in a reasonable time, accompanied by proof of their reliability, which will tell us not only the final yield but how that yield is obtained.

This leads up to another conception, namely, the critical periods of crops which will repay closer quantitative study in a country characterised by singularly short growing periods and rapidly changing conditions. By critical period, I mean the relatively short interval during which the plant reaches the maximum sensibility to a given factor and during which the intensity of that factor will have the greatest effect on yield. These periods seem to be associated with some phase of growth in which the plant is undergoing modifications demanding the rapid formation and movement of food material. Italian workers have found that the twenty days before the crop comes into ear constitutes an important critical period for wheat in relation to humidity and soil moisture. If during this period these factors are in defect of the minimum needed for the normal development of the plant, the crop will be small even if there is abundance throughout the rest of the vegetative period.

Our observations at Shahjahanpur indicate that two periods in the growth of sugar-cane have special significance: (1) May and early June when the tillers and root system are developing and (2) August and September when the main storage of sugar takes place. A check received at either of these periods permanently reduces the yield. The acre yield of sugar is positively and closely correlated with the amount of nitrate nitrogen in the soil during the first period, and with soil moisture and humidity in the second period.

Food crops pre-eminently demand combined nitrogen. You will remember how Sir William Crookes startled the world 30 years ago by the statement that the wheat eating races were in deadly peril of starvation owing to the rapid exhaustion of soil nitrogen. The age in which he lived had become accustomed to abundant supplies of cheap food from the great plains of the American continent. Fertility accumulated since the glacial period by luxuriant plant growth and bacterial activity suddenly became available for exploitation, and was plundered at an appalling rate by rough and ready methods of cultivation. Nitrogen was disappearing from the soil out of all proportion to the amount recovered in the crop. The extraordinary fertility of some of these new regions is shown by the data recorded by Shutt, an acre of soil to a depth of one foot containing from 20,000 to 25,000 lb. of nitrogen. This figure may be compared with the amount of nitrogen in an acre foot of soil in these provinces, which lies between the limits of 1,000 and 3,000 lb. I shall refer to this again shortly.

Crookes was almost the first to realise that there was a limit to cheap production from new land, but his forecast was too gloomy. He visualised the exhaustion of the chief granary of the western world within a generation or two. In some important respects he misapprehended the problem. He did not know as we know now that other agencies step in and stop the plunder of the soil before it has gone too far. It is only under improper methods of cropping and cultivation that permanent soil deterioration is a real and dangerous phenomenon. Land properly handled does not become exhausted. Much of the land of Europe has been cultivated since the days of the Romans or even earlier. It is, if anything, more fertile than ever. In India, we have in existence a method of farming which has maintained for ten centuries at least a perfect balance between the nitrogen requirements of the crops we harvest and the processes which recuperate fertility.

When we examine the facts, we must put the Northern Indian cultivator down as the most economical farmer in the world as far as the utilization of the potent element of fertility—nitrogen—goes. In this respect he is more skilful than his Canadian brother. He cannot take a heavy overdraft of nitrogen from the soil. He has only the small current account provided by the few pounds annually added by nature, yet he raises a crop of wheat on irrigated land in the United Provinces that is not far removed from the Canadian average. He does more with a little nitrogen than any farmer I ever heard of. We need not concern ourselves with soil deterioration in these provinces. The present standard of fertility can be maintained indefinitely. This is not my text. Production must be raised if we are to live in reasonable security and comfort.

In one respect Crookes was right. He foresaw that the intensification of production required more combined nitrogen than the limited supplies furnished by the distillation of coal and the nitrate deposits, to counterbalance the colossal wastage which civilisation and urban life bring about. The fixation of atmospheric nitrogen was as he put it, vital to the progress of civilised humanity. This problem has been solved in the last ten years and is one of the remarkable achievements of applied science. It could have been solved sooner if money had been forthcoming for long range research, but it took the war to bring us to our senses. Thirty years ago, the fixation of 29.4 grams of a mixture of nitrogen and oxygen at the expenditure of one horse power was recorded as a scientific achievement. In 1928–29 the estimated production of nitrogen compounds by synthetic processes was equivalent to 1.3 million metric tons of pure nitrogen, or over 6 million long tons of Sulphate of Ammonia, which can be sold at prices low in comparison with the prices of agricultural produce. We are entering on an era of nitrogen plenty which is bound to react favourably on the world's food production. One of our problems is to find out how we can make use of this discovery in India. The probability is that the full benefit of fertilizers will be realised only on land reasonably supplied with organic matter.

I may be allowed here to sound a note of warning. Great as are the possibilities offered by synthetic nitrogen compounds there is danger in adjusting our standards of living to increased production based entirely on imported fertilizers. They may be cut off suddenly by international disturbances. The war is too near an experience and the promise of universal peace too uncertain to ignore this side of the question altogether. It will be but a wise precaution to establish their manufacture in India when the correct way of using them has been worked out, their value demonstrated, and a demand created.

Our problem is more complex than the simple addition of nitrogen compounds to the soil. We have to face under peculiar conditions of climate the question of controlling moisture, organic matter, and air supply in the soil. of regulating the supplies of nitrogen so that it may be available in the right form and quantity when the plant most needs it, so that none may be wasted, and to make use to the utmost of those processes by which nature supplies nitrogen free of charge. These problems centre round the changes which organic material undergoes in the soil and the nitrogen transformations which accompany them.

We have two methods of soil improvement possessing enormous potentialities for increasing crop production and so simple in operation that they can be used by every body:

(i) the preparation of quick-acting manures from waste organic material.
(ii) the use of green manure crops.

I do not propose to discuss recent work on the first method The practical details have been worked out thoroughly by the Howards at Indore, and by Fowler, Richards, and their co-workers at Cawnpore. A paper on this subject is going to be placed before you by Dr. Fowler. I will not anticipate what he is going to say beyond remarking that the results which he has allowed me to examine, place in our hands a method of the greatest value for increasing the out-turn of rabi crops which require in this province a quicker acting manure than that provided by turning in a green crop.

We have been working for some years at Shahjahanpur on the utilization of green manure for sugar-cane. We have ploughed in on an average of three years' observations, 218 maunds per acre of sanai (Crotolaria juncea) which adds 50 maunds of dry organic material and 75 lb. of nitrogen to each acre. We have succeeded in raising crops of 850 maunds per acre without the addition of any fertilizing agent other than the sanai produced by the land itself.

I give below the results of 27 randomised plots in the treated and untreated fields in 1928.

	Sugar-cane maunds (82 2/7 lb.) per acre.	Raw Sugar maunds per acre.	Dry matter maunds per acre.
Green manure ..	847 ± 32	87.0 ± 3.6	246.1 ± 8.0
Control ..	649 ± 22	67.2 ± 2.6	200.1 ± 6.6

The illustration shows the crop in the field. The practical result is worth ninety rupees per acre. Our problem is to find out the conditions of cultivation necessary to decompose sanai in such a way that (1) well aerated soil containing sufficient organic matter to prevent rapid drying out is ready for the crop in March and (2) the nitrogen exchanges are such that this element is protected from loss until it is wanted, and is then present in a form which can be rapidly mineralised for the use of the young crop.

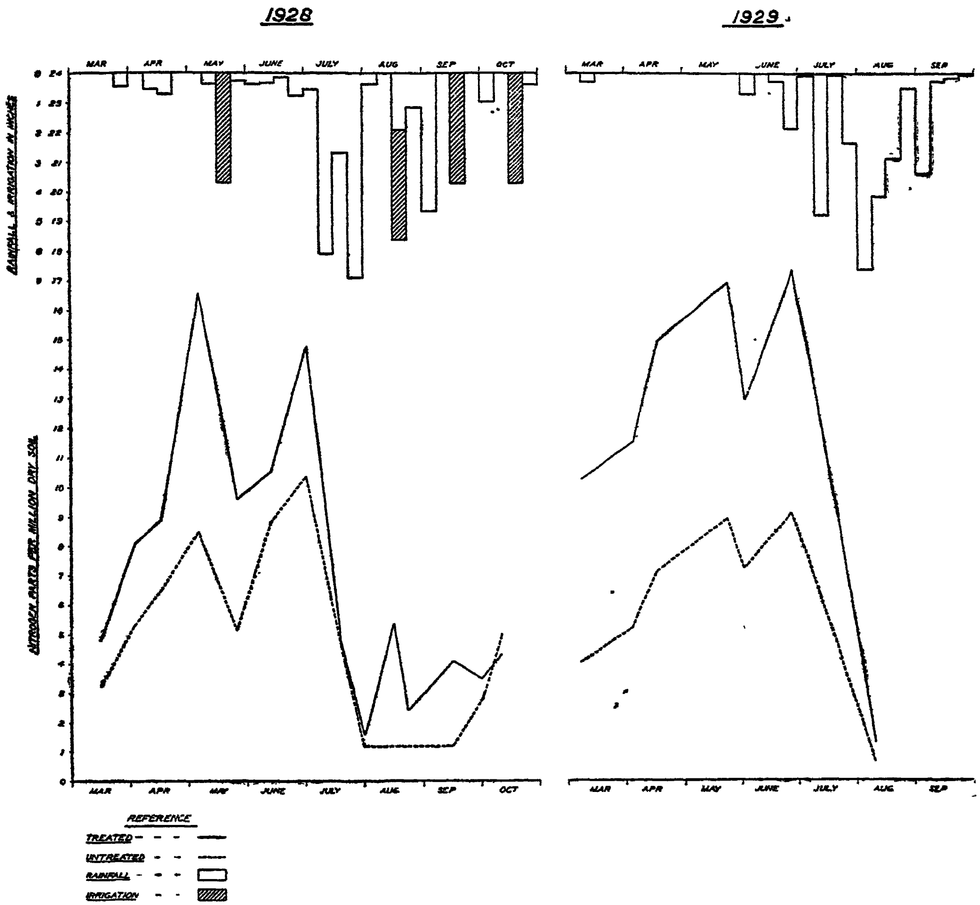
Our method of soil treatment is to bring about the early stages of decomposition in the presence of ample moisture. The rainfall after the sanai is ploughed in is carefully watched. If it is less than 5 inches in the first fortnight of September the fields are irrigated. In this way we secure in most of our soils an abundant fungal growth as the land slowly dries. We prevent large accumulations of nitrates in the autumn, which may be lost before the sugar-cane is sown, and concentrate the nitrogen in easily decomposable organic form in mycelial and microbial tissue, until it is wanted in mineral form in the spring.

Throughout the experiments we have made estimations of nitrate. The curves show the accumulation of nitrogen in the first foot of fallow plots in the treated and control fields in 1928 and 1929.

The accumulation of nitrate reaches its maximum in May and June just before the first heavy rain. At this time the crop is about ⅓ grown. We have not observed any subsequent large formation of nitrate up to the completion of growth in October. The final yields are in proportion to the mineral nitrogen present in the first period and this suggests at once the importance of available nitrogen in the early stages of the growth of sugar-cane. This view is by no means a new one. It has recently been developed by Gregory at South Kensington, and Rothamsted, who found that barley absorbed 90 per cent. of its total nitrogen when it had made about one-third of its growth. If it is substantiated by further work and found to apply to all crops it gives a clue to several improvements in soil management.

In our studies in connection with the intensification of sugar-cane cultivation we have been influenced by American investigations and methods, more specially those of the workers led by Waksman, who have studied the decomposition of cellulose and dead organic material in the soil. They have shown that the structure of the carbonaceous energy material in the soil largely determines the type of decomposition and the nitrogen transformations. If moisture and temperature conditions are favourable, the decomposition of cellulosic energy material, the chief constituent of green manure, is mainly accomplished by fungous activity resulting in the formation of large quantities of mycelial tissue and the removal of nitrogen temporarily from the reach of higher plants. The synthesised material is later decomposed by other micro-organisms forming mineral nitrogen and humic material, and a definite period of time is

NITRATE ACCUMULATION
GREEN MANURE EXPERIMENTS
SHAHJAHANPUR



required to complete these changes. A large volume of work has been published in the last five years. It explains much that was obscure regarding the utilization of green manure in

India, particulary the time factor to which Howard drew attention many years ago.

I now approach the last and most difficult part of my task, to estimate the increased production we may look for by the application of scientific methods to our agriculture. What I am going to say will be more readily understood if I give the production of wheat in a few countries for the crop sown in 1926, which was, on the whole, a good year throughout the world. It is as follows:

United Provinces—Irrigated	12·2	mds. per acre.
,, ,, Unirrigated	8·2	,, ,, ,,
Canada	13·2	,, ,, ,,
U.S.A.	10 7	,, ,, ,,
France	13·0	,, ,, ,,
Germany	17·5	,, ,, ,,
Great Britain	22·5	,, ,, ,,
Belgium	26·3	,, ,, ,,

A glance at these figures shows what an immense potential increase of production is open in many countries, especially in America and India. The physical possibility or perhaps even the limit of production in the United Provinces is shown by the yield obtained at the Shahjahanpur Research Station. In 1926 it was 28·8 maunds per acre. In the last 11 years, including two in which the wheat crop was a partial failure, 243 acres have yielded 5,945 maunds or 24·4 maunds per acre. Soil and climate do not impose a serious restriction on production. We cannot, however, take one striking instance of large yields achieved on a small acreage under favourable conditions as the basis of an estimate of the future production of the country as a whole. The actual level in any country is bound to be behind the ideal, no matter how well developed educational and propaganda machinery may be.

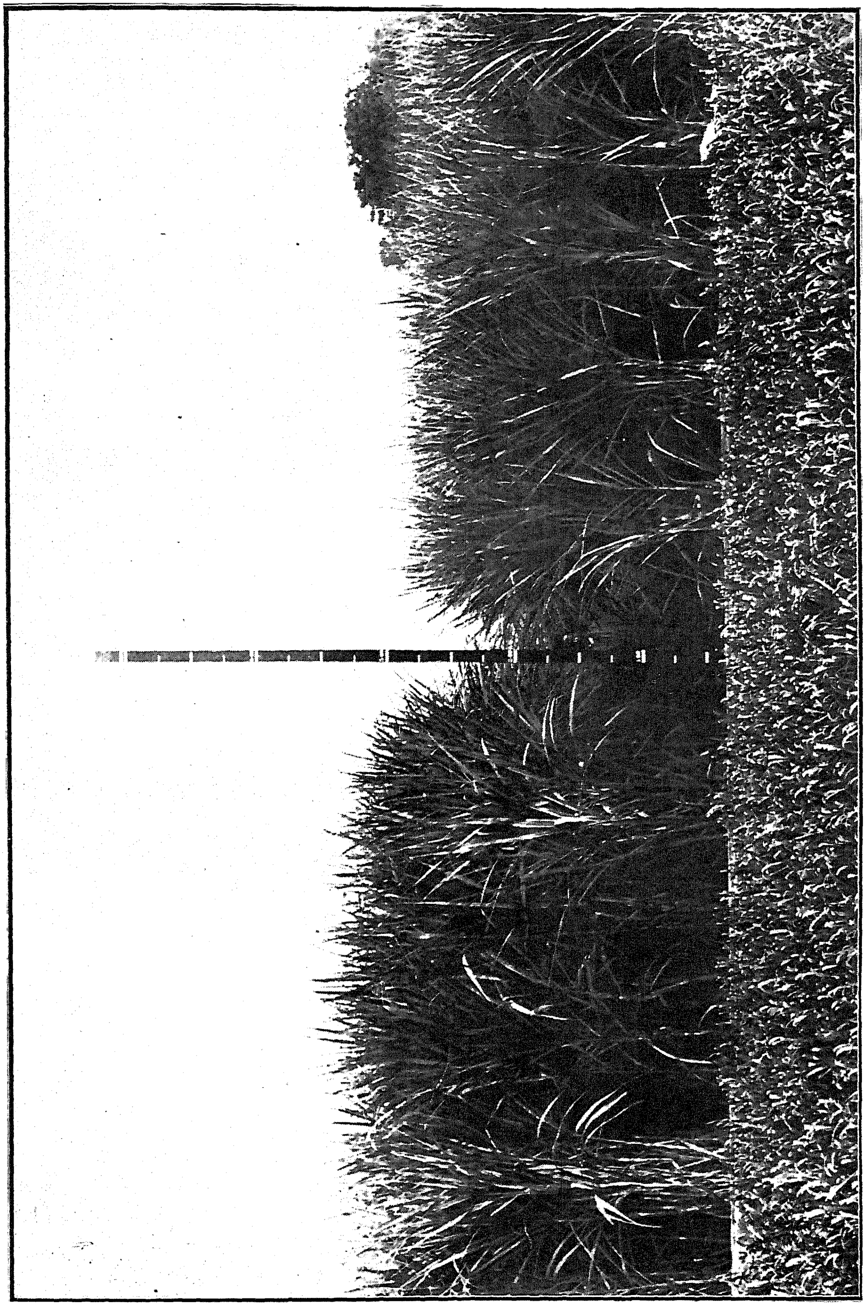
It is safer, if such a course be possible, to consider average results obtained in countries which have been compelled to employ intensive methods, but we have no adequate basis of comparison with our conditions. There is no example of a tropical or semi-tropical country in which scientific methods have been applied over a wide area by independent and unsupervised workers.

Sugar-cane cultivation in Java is often quoted as an example of what can be done. It illustrates the combined effect of *strictly supervised labour and scientific methods* on about one million acres of land, carried out with the object of gaining the highest possible interest on Dutch capital. It does not illustrate what we are aiming at in India—agricultural improvement initiated and carried through by the people themselves, as the result of education and uplift, on 300 million acres.

PLATE 1.

GREEN MANURE EXPERIMENT.

SHAHJAHANPUR, 1928–29.



CONTROL.

TREATED.

Let us examine the course of events in Europe and America and learn what we can from them.

In mediæval England the yield of wheat was 7 maunds per acre. When the consolidation of holdings was completed by the enclosures in about the last quarter of the 18th century the yield rose to 14 maunds per acre. It remained at this level until 1840 when a further advance was made possible by the use of better methods and the introduction of nitrogen fertilisers. By 1870 the yield had risen to 20 maunds per acre.

In America low yields and a growing industrial population are causing uneasiness. By studying agricultural conditions in other countries the conclusion has been reached that 47 per cent. represents a possible all round increase of production on the present cropped area. Experts do not agree as to the probable increase in the next few decades. This is placed between the limits of 10 and 30 per cent. These figures are based on considerations of labour. This, as I have said, scarcely enters into our problem in India. We have more people employed in agriculture per unit of cultivated land than any other country, with the possible exception of China and Japan.

The improvement of sugar-cane cultivation extends over 2,81,000 acres in 18 districts in the United Provinces and gives some indication of the possible course of events. The yield of the unimproved crop in a year of average character is 350 maunds per acre. We pass through four definite stages of improvement:

(1) Better cultivation of the old varieties, yielding 450 maunds per acre.
(2) The introduction of heavier cropping varieties accompanied by a further improvement in cultivation, yielding 600 maunds per acre.
(3) The introduction of some fertilizing agent, such as green manure, yielding 800 maunds per acre.
(4) The intensive cultivation of heavy cropping varieties, yielding 1000 maunds per acre.

The increase over the normal production is 28, 71, 128 and 185 per cent. The analysis of the returns is helpful in connection with our problem. In the more important sugar producing districts 70 per cent. of the sugar-cane area is planted with heavier yielding varieties. In some 30 per cent. and in a few only 2 per cent.

2,81,000 acres is almost exactly 33 per cent. of the total sugar-cane area in the 18 districts for which special returns are made; on this area the yield has been slightly more than doubled so that there is an all round increase in production of 33 per cent. This has taken 17 years to accomplish and brings the cultivator in 311 lakhs of rupees extra a year. I believe if such simple modifications of practice as the use of green manure crops and composts made from waste material, were applied to all our arable land, production would be more than doubled; but this means that every cultivator would be conducting his agricultural operations in a scientific manner—a state of affairs not yet reached in any country. The point is that it is not to be expected. We must allow for the inertia which will retard the general adoption of improvements in so large a country as India. After giving due weight to this and taking into consideration the abundance of our labour resources and the extraordinary response of our soil to better treatment, it is reasonable to believe that within the next two or three decades we may increase the all round out-turn of our cropped land by 30 per cent. in normal seasons. But I assume that much more money will be spent on scientific research and extension work in villages than is now spent.

I hope I have said enough to show that soil improvement in India is worth an effort. It requires generous expenditure from the national exchequer, and there is no better investment, for it gives, to use the words of Huxley, an immediate return of those things which the most sordidly practical man admits to have value. We are working in times well suited for agricultural development. Indifference is giving way. There is a stir throughout the countryside. We can call the movement what we like, but the plain fact is that men are no longer satisfied with a life, which provides only hard work and barely enough to eat. Many things are being suggested, but they deal more often than not with preliminaries to social well being, and leave untouched the vital problem of producing more food. In the end the scientific worker will come to the rescue, and the solution will be reached through the experiment station.

Section of Agriculture.

Abstracts.

SOIL IMPROVEMENT.

1. Further experiments on the preparation of organic manure.

Gilbert J. Fowler, H. S. Chaturvedi *and* **R. N. Johri.**

During the past year the experiments have been continued with special reference to the following problems:—

(1) In what way can cow's urine be most economically conserved and utilised ?
(2) Does the use of "activator" in any way facilitate the fixation of atmospheric Nitrogen ?
(3) Is it possible to acclimatise in India leguminous plants which have been found of value as green manures in other countries ?
(4) How can such plants best serve as raw material for composts ?

It has been found that while cow's urine is an important agent for facilitating fermentation it appears to play no part in the fixation of Nitrogen.

On the other hand, there is evidence that the presence of "activator" induces quick rotting and also fixation of Nitrogen.

Two out of three leguminous plants tried were successfully grown.

2. Studies on soil Actinomyces. Part IV.

P. K. De, Bangalore.

The investigation was undertaken with the object of ascertaining the rôle played by Actinomyces in the decomposition of complex organic matter in the soil. This paper deals with the utilisation of different carbohydrate culture media by Actinomyces. Of the three strains that were studied, viz., A-Scabis, A-Chromogeus, A-Albosporeous, the last one was found to be most active, using up different carbohydrates in the following decreasing order—starch, glucose, canesugar, arabinose, cellulose. Influence of different concentrations of carbohydrate materials, reaction of media, and different nitrogen sources on the assimilation of carbohydrates by the organisms have been studied.

3. The decomposition of organic matter in water-logged soils.

N. Desikachar, Bangalore.

Decomposition of different types of plant materials in soils was studied. Distribution of carbon and nitrogen in different forms and its relation to soil conditions were determined.

4. Periodicity of the nitrate content of soils.

L. S. Nigam *and* **H. N. Batham.**

The paper deals with the data obtained in different countries of the world regarding the seasonal variations of the nitrate content of soils along with those of the authors and the conclusions drawn are the following:—

1. That the greatest accumulation of nitrates takes place during summer months and the least during winter ones.
2. That there seems to exist a close relationship between the fluctuations of nitric nitrogen content of soils and different seasons of the year.
3. That the solar activity, which appears on the earth in the form of different seasons of the year, appears a most important factor in controlling the nitrifying bacterial activity in soils.

5. Nitrogen fixation in 'Kalar' soils as influenced by different Calcium treatments.

V. A. Tamhane *and* P. G. Krishna, Sakrand (Sind).

It was intended to study the effect of the application of various forms of calcium salts on Nitrogen fixation in 'Kalar' soils at Sakrand in conjunction with the work on the effect of these salts on the plant growth. Also Nitrogen fixation in liquid media containing the various salts in the same proportion as found in the water soluble salts in the 'Kalar' soil, was studied. The following calcium salts were added to both the media to have ca. ·2% equivalent:—Calcium Oxide, Chloride, Carbonate and Sulphate.

In solid media (soil) ·2% calcium equivalent of Calcium Chloride and Calcium Sulphate treatments had stimulated nitrogen fixation; while Calcium Carbonate and Calcium oxide treatments had depressed the nitrogen fixation, the carbonate to a much less extent than the oxide. No relation was found between these effects and the reactions of the soils with the different treatments.

In liquid media ·2% calcium equivalent of Calcium Carbonate and Calcium Sulphate had stimulated nitrogen fixation. The carbonate much more than the sulphate. Calcium chloride treatment had depressed the nitrogen fixation, while in the case of those treated with calcium oxide there was hardly any nitrogen fixation, and no bacterial growth was observed in these flasks. The initial reaction and its subsequent changes seem to be responsible for these observed effects.

Azotobacter strains were isolated from this soil and are being studied.

6. Correlation studies of the Punjab Soils.

Mehta Mukand Lal *and* R. P. Sarathy, Lahore.

The data on the Punjab soils by Lander, Ramji Narain and Mukand Lal has been studied statistically and certain significant correlations are found to exist between certain soil constituents.

Soil characteristics of different types of soils suited to different crops have also been brought out.

7. A biochemical study of soil treated continuously with sewage.

N. D. Achar *and* N. V. Achar, Bangalore.

Physical, chemical, physico-chemical and microbiological changes taking place in soil treated continuously with sewage have been studied.

8. Study of movement of water and soluble salts in the soils at the Agricultural Research Station, Sakrand (Sind). Part II. Study with repeated doses of irrigated water.

V. A. TAMHANE, J. A. DAJI *and* P. G. KRISHNA, Sakrand (Sind).

The first part of this paper dealing on single doses of irrigation water for leaching out soluble salts was read at the last Science Congress. In this paper are reported the results on the application of varying amounts of irrigation water with varying periods of interval between irrigations, to make the total amount of irrigated water to 29 inches. Also are included the data obtained from the same plots after a lapse of two years from the period of experimentation.

Repeated doses of irrigated water were effective in leaching out some of the soluble salts. As far as the soluble salts are concerned, a smaller dose of water given more frequently (for instance 2" every 10 days) was found to be more effective than larger doses given at longer intervals (for example 3" every 15 days). The irrigated water drained off well beyond a depth of five feet, indicating that leaching out of soluble salts in such soils would not be a very difficult matter. There was no deposition of the soluble salts in any of the soil strata to a depth of 6 feet. Translocation of the leached salts to the surface layer would not occur if these salts are leached into the lower soil strata (below a depth of 5 feet), unless the water table rises very close to the surface soil layer. In such soils wherein appreciable amounts of Calcium Salts are present, Sodium salts are leached to a greater degree than Calcium Salts, and of the Sodium Salts Sodium Chloride is most easily leached out from the surface soil layer.

9. Reports for reclaiming Usar lands of the United Provinces.

L. C. SHARMA.

The total area of Usar lands in the United Provinces of Agra and Oudh amounted to 3,129,053 acres in 1888. The principal salts which made these lands unfit for growing crops are sodium carbonate, sodium sulphate, and sodium chloride. Such lands are generally heavy clay soils and very often termed as *parti* or waste lands. The experience gained in the past shows that the more vigorously they are cultivated, the more perfectly are the said salts prevented from accumulating at or near the surface and that they are capable of being reclaimed without incurring any heavy expenditure.

The Department of Agriculture, U.P., carried out a series of experiments for reclaiming Usar lands at various centres in the Provinces, some of which proved a marked success. Certain methods for reclaiming Usar lands under trial at the Experimental Station, Partabgarh, are found very encouraging and highly appreciated by a number of zamindars and cultivators who also tried them for reclaiming their Usar lands. These methods are mentioned in the article of which this is the abstract.

10. Hard calcareous sub-soils in South Bihar. Their morphology and treatment.

M. N. GHOSH, Sabour.

These sub-soils exist generally in South Bihar to very great depths at some distance from the Ganges channel. They form parts of the older Gangetic alluvium and their hardness is due to the formation of compact gels by the absorption of lime carbonates by the soil colloids. Whenever they come near the surface the land becomes infertile. Continuous cultivation improves the land but the improvement is not much apparent within two or three years, but very visible improvement is noticed by treatment with sodium salts preferably nitrate of soda which seems to attack the gels and break their compactness.

11. Note on electric farming.

S. S. NEHRU, Rae Bareli.

Tests have been made under—I. Seed Energetics;
II. Soil Energetics;
III. Both.

Under I, various seeds were energised by high-tension electric sparks (1000 to 10, 000 volts) for 5 to 10 minutes and sown in test plots, control plots being sown with ordinary seed.

Under II, different soils from loam to sand were energised by means of a "tickler" or discharge-tube through which air was pumped and sparked at the orifice. Its conical nozzle was driven into the soil at various points and sparked air pumped for 2 to 5 minutes every time.

Under III, the methods of I and II were combined.

Tests have been made with *Sanai; Mustard; Wheat; Cauliflower; Salad*; *Mango Seedlings; Juar; Broomcorn; Bajra*, *Zinnia; Chrysanthemum*; and *Gomphrema.*

Every seed, plant and soil has responded to treatment, most actively the cereals, then mustard and sanai. Flowers have also reacted notably. For example: Energised Juar grew from 81 to 280 Cm. control from 101 to 215; Energised Broomcorn from 115 to 340, control from 115 to 264. Energised Bajra has developed more ears than the control one. Flower-plants have yielded more numerous and bigger flowers. Unseasonal sowings, energised, have thriven; while control ones died out.

Tests continue.

12. Kudzu Vine (*Pueraria thunbergiana*).

N. V. JOSHI, Pusa.

Kudzu vine was grown and kept under observation for three years and the results of the experiments are given below :—

1. Kudzu Vine is a very promising perennial crop.
2. It has been grown from imported seed but it can be better propagated from runners which develop rootlets at the nodes during the rains. Kudzu is slow to cover the ground but when once established it thrives under drought as well as excessive rain.
3. The germinating power of the seeds rapidly deteriorates. April is the best time for growing it from seeds and August and September for propagating by rooted runners.
4. Its growth in the early spring growth makes it particularly suitable for growing for pasture or cutting it for fodder.
5. It is a heavy yielder and grows quite well on land near the hedges or trees.
6. Kudzu is well worth the trial for grazing on poor rocky soil as well as in places where only Kush and other grasses grow and in places liable to be under water like the Dhab areas.
7. If grown on cultivated soil Kudzu is difficult to eradicate entirely from arable land the first year such land is needed for other crops.
8. It contains, as an average 0.4 to 0.5 per cent. nitrogen and in case any cutting is not required for feeding stock it may be utilised for green manuring.

9. The use of its stem for fibre is well worth investigating.
10. Its roots contain about 40 per cent. starch.

13. A preliminary note on the surface run-off and soil-erosion.

N. V. KANITKAR *and* G. M. BAPAT, Poona.

The authors have conducted experiments to determine the surface run-off of rain water and soil erosion during the monsoon season of this year at Manjri Dry Farm Experimental Station. The difference in run-off and erosion under three different treatments of soil are studied with one definite gradient of three in hundred. The area of each plot is half a guntha or 1/80 of an acre, and each plot is separated from the other by a partition of galvanised plane iron sheet fixed 9″ deep in the soil on three sides. Masonry tank is built at the lower end of each plot in which water and silt are collected after each day's rain. The results are summarised below ;—

(1) The total rain-fall from June 1st to 10th October, 1929, amount to 17.06 inches received in 63 rainy days.
(2) Only on eleven days the rains caused run-off of water and soil erosion.
(3) The largest run-off took place from the ploughed plot, the harrowed and untreated being next in order. The difference was more marked at the beginning but later on all plots behaved very similarly.
(4) The quantities of silt removed were again highest in the ploughed plot, untreated and harrowed coming in order.
(5) The quantities of water lost by run-off varied from 34 to 38 per cent. of the total rain-fall of the season and nearly 50 per cent. of the useful rain.

14. The effect on the soil complex of applications of sodium nitrate to swamp paddy soils.

B. VISWA NATH *and* S. KASINATHAN.

Continued applications of sodium nitrate does not alter the cationic composition of the clay-complex and the beneficial effects of the manure are due in large measure to its powers of flocculating the soil colloids.

15. Determination of exchangeable calcium in calcareous soils.

B. VISWA NATH *and* S. KASINATHAN.

The need for a reliable method of determining exchangeable lime for soils rich in carbonate is emphasised. Based on the influence of bicarbonate concentrations on the solubility of calcium carbonate, one such method has been evolved.

16. Effects of Different Kinds of Soils on Rice.

S. K. MITRA *and* P. M. GANGULI.

The effects of different kinds of soils on rice were tried at the Karimganj Farm with a view to find out the differences in root and vegetative growth as well as in yield. Halved cement barrels were used and ten different soil media, viz., the clay, clay loam, sandy clay, gravelly clay, loam, sandy loam, gravelly loam, sand, gravelly sand and gravel, were used. The results indicated that rice has a wide range of adoptation for its growth in different kinds of soil provided it is clayey in nature, but the clay soil containing 40%–50% clay allows the best growth of the plants.

THE ORGANIZATION OF AGRICULTURAL RESEARCH.

17. The Organization of Agricultural Research.

ALBERT HOWARD *and* GABRIELLE L. C. HOWARD, Indore.

One of the problems of the moment, in the organization of agricultural research in the Empire, concerns the possible division of the work between the local and the central institute. Most attempts in this direction have failed in the past and are likely to fail in the future for the reason that the problem is not based on the merits of the case but has arisen either through accidents of administration or from failure to realize what successful research work in agriculture entails in the way of staff and facilities. The solution of the problem becomes much easier if the artificial sub-division of the subject, into long-range and local problems, is given up and the more natural one of research and demonstration is adopted in its place. The ideal system of conducting agricultural research in India and other parts of the Empire appears to lie in the simplification rather than in the elaboration of the organization. Any attempts to overstrain system of organization in the hope that they may replace competent investigators can only end in failure. In research the man is everything; the organization is a minor matter.

18. The Indian Universities and the improvement of Indian Agriculture.

B. C. BURT, Delhi.

As the result of developments on both sides the position is now more favourable for co-operation between the universities and agricultural research institutes than in the past since most agricultural colleges are affiliated to universities and many universities have raised their standard of teaching in pure science and made definite provision for scientific research. There is ample room for co-operation between the universities and those engaged on the improvement of agricultural practice and the Imperial Council of Agricultural Research, on which the universities are directly represented, affords a new opening for such co-operation.

19. The Imperial Council of Agricultural Research, its constitution, aims, and functions.

SIR T. VIJAYRAGHAVACHARYA.

The Imperial Council of Agricultural Research has been set up as a result of the recommendations of the Royal Commission on Agriculture in India. Its functions and constitution and aims are described and particular attention is drawn to the fact that it is an all-India body on the Governing Body of which each province is represented by its Minister of Agriculture, the Central Legislature by three elected representatives, and commercial interests by one representative each of the Associated Chambers of Commerce of India and Ceylon and the Federation of Indian Chambers of Commerce. There is also legal provision enabling Indian States to be represented. The Advisory Board is a technical body containing representatives of the agricultural and veterinary departments, universities, research institutes and other bodies engaged on scientific research. The research Council has been registered as a society and has funds of its own for the promotion of research, the dissemination of scientific, technical, and economic information and for the assistance of post-graduate training in agricultural science. At present the greater part of its funds are provided by the Government of India but a munificent donation of 2 lakhs has been made by the Hyderabad State and other benefactions are hoped for. The Research Council has no research institute of its own and will promote research by grants to existing institutions for specified investigations.

THE INDIAN SUGAR INDUSTRY.

20. Problems of the indigenous sugar industry of India.

KHAN BAHADUR SYED MOHD. HADI, Bhopal.

The paper deals briefly with the past and present condition of the indigenous Sugar Industry and the trade in Indian sugars. It points out the reasons which led to the gradual decline in the industry since the import in considerable quantities of foreign sugars began. An account is given of the researches made in Bhopal with a view to obtaining a much larger recovery of sugar from S. 48 and a number of Coimbatore seedlings and exotic canes than is possible under the Rohilkhand system. Improved methods of growing superior varieties as "plant" and ratoon are described. It has been shown how by the use of efficient mills for crushing the cane, of a standard and an auxiliary plant of special design for boiling the juice and of a high speed centrifugal of special construction for curing the massecuite, from 7 to over 8 per cent. on cane, of white sugar of good quality (1st and 2nd) can be produced with no expensive appliances or high technical skill, in villages, at a cost which would enable the Indian manufacturer to hold his own in the competition with which he is confronted.

21. Results and object lessons from a half century of cane breeding.

NOEL DEER.

An account of the development of sugarcane breeding is given since the rediscovery of the fertility of cane seed by Soltwedel and by Harrison and Bovell.

Special reference is made to the work in Java culminating in the production of P.O.J. 2878 and to the work initiated by Barber in India.

The value of, and the necessity for, the continuance of this work for Indian Agriculture is pointed out.

22. Suggested method of studying sugarcanes for breeding work.

KIDAR LALL KHANNA *and* RAO BAHADUR T. S. VENKATRAMAN, Coimbatore.

The life histories of three cane varieties up to the end of about 20 weeks from time of planting are given in some detail.

The three varieties are *Katha*, indigenous cane of the Punjab, *Co. 205*, replacing *Katha* chiefly in the unirrigated tracts of the Punjab and *Co. 285*, a future rival of *Co. 205* and a distinct improvement over *Katha* and *Co. 205*.

The studies include the number, development and functioning period of '*sett*' roots, the periodic developments of '*shoot*' roots, bud germination and the bending of the main and subsidiary shoots at different stages of growth.

A correlation is indicated between shoot root development and tillering.

The growth periods of the varieties are examined and it is found that the shoot growth is correlated with root development.

The first fourteen to twenty weeks represent a rather critical period for sugarcanes in the Punjab; and, on account of their thriftier shoot development, the Coimbatore seedlings are better adapted to this period of unfavourable conditions than the indigenous canes.

It is suggested that studies of developmental stages and characteristic of growth would be of considerable use in the selection of canes for particular localities; and such studies are an important aid in sugarcane breeding.

23. Sugar industry in India as compared to those of other countries.

K. C. Banerji, Allahabad.

The object of this communication is to study the conditions which govern the Sugar Cane Industry of different countries, such as Java, Hawaii, Philippines, etc., in order to find out a basis of comparison whereby to fix a place for India in the international competition. Indian industry according to modern methods has only been considered. The system of cane supply, control in cultivation and factory work, Central Organisation, etc., in different countries have been discussed and an attempt has been made to find out a solution for improving the present condition of the Indian Cane Sugar Industry. The control figures of the milling and boiling houses in different countries have been discussed with reference to special machinery employed in those countries.

24. Tilling, planting, and manuring of sugarcane fields in Java.

K. C. Banerji, Allahabad.

The high land lease and the impossibility of growing ratoons necessitate the cane sugar industry of Java to get the highest possible output from unit planted area diminishing the cost of production. The cultivation has to be made as intensive as possible. Reference has been made to the highest degree of the tilling of the soil, specially to the Reynose system, and also ploughing system, labour being cheap and abundant in Java. The tertiary sugar cane soils belonging to the miocene layers in their three formations have been discussed. The paper will give a short survey on planting, its usual method and the materials used. (Bibit, Bergbibit, Rajoengan, etc.) There is also a brief account of the essential change in the planting material caused by the introduction of POJ 2878 on a large scale. Lastly general remarks on manuring have been made with discussions on the following classes of manures as used in Java, on their advantages and disadvantages;—Nitrogen containing manures, Phosphate containing manures, combined manures, Inorganic manures, organic manures, Green manures, etc. The time, form, manner, and amount of the manures to be administered have also been discussed.

25. Mosaic disease of sugarcane in India.

W. McRae *and* L. S. Subramaniam.

Mosaic disease of sugarcane was first observed in Java in 1892 and since then it has been recorded in almost all the cane growing countries of the world. It was first observed in India in 1921 on D 74, and Sathi 131 and now has been found in almost all cane stations in India.

The mottling of the leaves and stem is the symptom by which the disease is recognised.

The disease can be transmitted to healthy cane by the injection of juice from infected leaves It has also been transmitted from cane to Andropogon Sorghum and Zea Mays.

Aphis maidis has been proved to be carrier of this disease in maize.

Heavy losses have been reported in other cane growing countries but so far it has not done much damage in India.

Planting of resistant varieties and roguing the standing crop are the chief means for the control of the disease.

CROP PRODUCTION.

26. The classification of cultivated rice in the United Provinces.

R. L. Sethi, Cawnpore.

While handing a fairly large number of rice varieties in the United Provinces, and noticing that the subject had not been studied before from a systematic point of view in these provinces, the necessity of a scheme of classification became apparent. 1200 samples were collected from different districts of the province, and a thorough pure line selection was continued for five successive years, when ultimately 135 types were selected as pure varieties possessing constant characters. On making a complete study of various characters of the rice plant it was found that the characters of the grain are more constant and more useful than other vegetative and agricultural characters. These grain characters (colour, size and shape) have consequently been employed as the main-heads of the present scheme of classification. A history of the previous work on classification has been given, and reasons for employing grain characters as a basis of classification are enumerated. The volume of the grain has also been measured, and the relationship between the size of the grain and that of the volume is shown. The product of the length × breadth of the hulled grain harmonizes with the volume, and the former divided by the latter equals 1. The scheme of classification and the grouping of varieties is shown, and various distinctive shapes of the rice grain found in the United Provinces are described.

27. Disturbing factors in flowering and fruiting capacity of the cotton plant in United Provinces.

B. Ram Prasad.

Total number of bolls per plant is the result of the number of flowers setting throughout the flowering season. In order to correctly arrive at the differences in the flowering capacities of two particular varieties, a count of the actual number of flowers each day was made throughout the season on the ten best flowering plants for three years.

In spite of the variations found in the number of flowers per day on account of varietal differences, the number appearing each day is also influenced by the bright or the cloudy conditions of weather prevailing in the flowering season.

Each boll contains about 2 grams of cotton. In order to obtain a good average yield of say 8 maunds per acre we should have only about 7 bolls per plant on an average with a spacing of 1½, from plant to plant and same distance from line to line if all other conditions remain ideally favourable.

The 30 days' period from 2nd week of August till 2nd week of September is the most favourable period for setting in early cottons. If there is a disturbance during the period the crop suffers but favourable conditions tend to give better outturn per acre.

28. Classification of Indian cottons.

G. L. Kottur.

The indigenous types of cotton cultivated in this country are classified into 3 species on the basis of colour in the leaf as *Gossypium herbaceum, Gossypium neglectum,* and *Gossypium sanguinum.* The leaf in *G. herbaceum* is yellowish green without any basel spot, in *G. neglectum* dark green with red spot at the base, and in *G. sanguinum* reddish green, both the basal spot and the veins being red. Each species is further divided into a number of sub-divisions on the characters of lobing, colour of flower, stem, habit of growth, hairiness, bracts, size of flower, boll, seed ginning percentage and staple length. These divisions enable us to clearly distinguish all the cottons now cultivated in the country. The possibilities of new types coming into cultivation as a result of hybridisation are considered and the present classification is deemed to be sufficiently wide to include them.

29. Improvement of Sind *deshi* cotton.

K. I. Thadani *and* B. B. Mulchandani, Sakrand (Sind).

1. Sind *deshi* cotton consists of a mixture of four neglectum varieties differing in the colour of the flower which may be yellow or white, and the nature of leaf lobes which may be narrow or broad in addition to several other characters. The yellow flowered types preponderate to the extent of 70 per cent.

2. When two pure strains differing in the colour of flower were grown in alternate rows, the incidence of natural crossing showed that (i) about 16 per cent. of the plants got vitiated, (ii) about 6 per cent. of the flowers got crossed, (iii) about 3.3 per cent. of the ovules showed cross pollination, (iv) natural crossing took place from 3 to 22 feet. White flowered plants picked from a field where yellow flowered types preponderate as mentioned above showed that 50–84 per cent. of them had got contaminated.

3. Unit selection in Sind *deshi* cotton has resulted in the production of a strain of roseum cotton known as 27 W.N. which is capable of (*a*) yielding over 20% more kappas per acre than ordinary seed, (*b*) early crop, (*c*) 5 per cent. higher ginning outturn, (*d*) greater premium over ordinary cotton on account of rough feel and bright colour of cotton. This cotton is now the standard *deshi* cotton of Sind. The seed multiplication scheme consists of (i) selfing patch sown with selfed seed of single plants, (ii) seed patch of an acre and a half, (iii) seed farm area of 30 acres, (iv) departmental zamindari area of 300 acres, (v) registered growers area of 3000 acres, (vi) Taluka development area of about 60,000 acres. Each stage is fed by the preceding stage and thus purity is maintained. The scheme is progressing and expanding every year.

30. Cultivation of Broomcorn in India.

S. S. Nehru, Rae Bareli.

In the *last paper* at Madras, results of successful tests with Indian broomcorn under European, African, and American conditions were communicated. Encouraged by the good results obtained, the same selectivised, hardened, and resistant seed has since been supplied to 7 *Government* Farms, 11 *Taluqdars'* farm and 6 other *private* farms in India. The *Government* Farms are in Muttra, Partabgarh, Rae Bareli, Poona, Gwalior, Dharwar, and Sholapore. The *Taluqdars'* farms are mostly in Rae Bareli district. The *private* farms are in Allahabad, Cawnpore, Jhansi, and Lahore. Thus, tests with broomcorn are being made in all representative parts of the country.

Results to date show cent per cent. germination everywhere in 3 to 6 days and in all soils ranging from sand to clay. Broomcorn has grown under all conditions, even when local *sorghums* have failed. And the growth has been notably rapid, the plants in a characteristic field measuring 1′-8″, 3′-8″, 5′-10″, 7′-10″, 8′-5″, 10′-5″, and 12′ in the first seven fortnights respectively. A very healthy plant with tall stalk, thick base, and long panicles has been obtained.

Further results will be communicated subsequently.

31. The growth of the cotton plant in India—II. The predetermination of subsequent growth variability and variation in the "growth resistance potential" at the early seedling phase, and its explanation in terms of external factors (temperature) and internal conditions (hydration of growing tissues).

R. S. Inamdar *and* B. N. Singh, Benares.

1. *The outlook and the procedure* :—This series of investigations was instituted with a view to study the growth mechanism of plants, choosing an economic plant for the purpose, viz., cotton For obtaining the requisite variability of growth reactions for an estimation of internal factors, the atmospheric factors of the environment were used as the variables. The variability of the atmospheric factors was secured by growing the plants under *field conditions* in series at successive intervals of a fortnight in the summer of 1925. The factors of the substratum, such as, the moisture content and the "nutritional" constituents, were kept above the maximum demands which the plant is believed to be making on the substratum. A full record of atmospheric factors was obtained from the local Meteorological Station.

The results now described throw additional interesting light on the growth mechanism of plants for theory and practice, and also emphasise the significance of *hydration factor in growth and senescence.*

Organismal growth variability was also designed by growing two different varieties of cotton, viz., *Dhulia neglectum* and *Gossypium herbaceum.* The results are described below separately.

Growth magnitudes were measured in terms of the dry weights produced by the entire plants and its organs (including the reproductive organs). The extent of the assimilating and the transpiring surface and the march of the respiratory intensity as growth proceeded, were also recorded at corresponding periods of growth. Though the results are not described here, they have, nevertheless, been utilised in arriving at the final conclusions.

From a quantitative analysis of growth data, an analysis is attempted of the growth mechanism and the approach of senility, including the nature of reproductive growth as opposed to vegetative growth.

Interesting and striking conclusions emerge from these studies on the economic side of the growth of the cotton plant and of crop plants in general.

2. *Summary of results and conclusions* :—The time growth curves are of the usual sigmoid type and conform, on analysis, to a variation of the exponential type of the equation of the form, $\text{Log } W = n \log t + a$, where W=dry weight, t=days after germination, and a and n=constants. Therefore a straight line is obtained when Log W is plotted against log t.

The slope of this straight line is made a measure of the march of growth towards senescence in each series of sowings.

Curiously the gradient of the march of growth remains identical in all the series, in spite of variations in the atmospheric environment. Consequently the *relative rates of growth* are identical in all the series in corresponding periods of growth.

But growth variability is manifest in different series in many directions (see below). *This variability is, therefore, predetermined at a very early seedling phase of growth* (which is the critical stage in growth) in response to external conditions.

The predetermination leads to a series of resistences to growth in the subsequent march of growth toward senility, in accordance with the environmental conditions to which the plant becomes subject. Therefore the term "Development of *Growth Resistence Potential*" is given to this early predetermination.

The degree of predetermined resistence to growth at the early seedling phase carries the downward march of the relative growth rate curve to zero intensity sooner or later in different series of sowings and determines the period of approach of senility and the final stoppage of growth as also the number of times the flower buds appear in the course of growth in each series.

Growth variations in different series of sowings are manifest under five headings, viz., (1) variations in the final dry weights in corresponding periods of growth, (2) The occasional sudden breaks in the growth of plants, especially when the first reproductive initials are laid down, (3) the relative retardation of the development of reproductive primordia including the shedding of flowers and bolls, (4) the number of times the reproductive primordia appear, and (5) the period of approach of senility and the final stoppage of growth.

All these growth variations reduce themselves to the resultant effects of one primary variation, viz. differences in the resistences to early growth (production of dry matter) within about 30 days after germination. The subsequent variations are the resultant effects in various directions of the superimposition of the later atmospheric conditions on this primary variation.

Therefore the early predetermination consists in the change in the seedling phase which leads to the primary variation, the development of varying degrees of resistence to the early production of dry weight. The predetermined change is a *potential* for the subsequent development of growth resistence.

The "growth resistence potential" is explained in terms of two significant variations, (1) variation in the "growth potential" of the growing cells in the early meristem, and (2) variation in the number of cells available for cell division and growth.

Among causative factors in predetermination, temperature effects appear to be the most important. Radiation effects do not assume significant proportions in the open in the tropics.

It is suggested that one of the effects of temperature is to introduce variations in the number of cells available for cell division and growth in the early meristem.

Of the many internal conditions, the hydration factor of the growing meristem appears to play a very important part in contributing towards the final change. It is suggested that variations in this factor are introduced in the early predetermining phase of growth by variations in the intensity of transpiratory loss of water.

This hydration factor appears to play also a very important part in the approach of senility and the final stoppage of growth. It is suggested from independent investigations on the specific conductivity of plants with monopodial and sympodial modes of growth that the hydration of growing tissues is influenced by as growth proceeds.

The control of the germination stage is of paramount importance. This done, "Out of season" growth also may prove successful within certain limits.

So far as the locality of Benares is concerned, the high yields obtained per plant justify the earlier conclusion that cotton can be grown very successfully in this tract. The requisites are that very early sowing in the beginning of summer should be accomplished and the plants maintained by irrigation till the monsoon rains commence. The short-growing variety gives bumper yields under these conditions.

32. The growth of the cotton plant in India—III. The relation of reproductive growth to vegetative growth as judged by the growth curves in Dhulia Neglectum. The physiological significance of maximal humps in growth rate curves antecedent to successive initiations of reproductive growth.

R. S. INAMDAR *and* B. N. SINGH, Benares.

This paper deals with the relation of vegetative growth to reproductive growth and the explanation of variability of reproductive growth in terms of internal conditions and previous growth history.

Part I of this series established a close connection between the appearance of a maximal hump in the relative growth rate curve and the appearance of reproductive buds. This is confirmed in the present series which indicate 2 or 3 maximal humps in the generally descending growth rate curves in each series, each time antecedent to the appearance of reproductive buds.

Evidence is accumulated by the second author elsewhere that the period of each maximum in the relative growth rate curve is also associated with a corresponding maximum in the respiratory index of the growing meristem, and in the general constructive activity of the protoplasm (relating to both carbon and nitrogen anabolism).

These maxima *have a deeper physiological significance in that those periods are characterised by a general increase in the metabolic activity of the protoplasmic complex.* It is also concluded that the periods of appearance of maximal humps are also the periods when the reproductive initials are laid down internally, though their emergence as visibly recognisable structures externally is more or less delayed depending upon the "nutritional" balance available in the plant.

Part I of this series of communications indicated that the period of first emergence of reproductive buds is liable to vary in different sowings. The present series of sowings being made in only one season, viz., the summer, this variation is negligible (the period of first appearance of flower buds ranging from 47 to 52 days after germination in all the series).

The period of emergence of reproductive buds as visible structures is made up of two component phases, viz., (*a*) the *initiation* of reproductive phase (as judged by the maximal humps on the growth rate curve), and (*b*) the *development* of reproductive primordia into externally visible flower buds

(*a*) The *initiation* of the first reproductive phase varies in all the four series of sowings (38, 27, 25, and 24 days after germination respectively). This variation is correlated with an *inverse* variation in the antecedent production of total dry matter in each series. The period of *initiation* of reproductive phase in each series is, therefore, correlated in some way with predetermination in the seedling phase.

(*b*) The interval between the *initiation* of reproductive phase and the *emergence* of reproductive buds as externally visible structures (9, 18, 25, and 26 days respectively in all the four series) varies, however, in the *same* direction as the antecedent production of total dry matter in the plants. This phase is, therefore, directly correlated with the ' nutritional " balance between the vegetative and the reproductive growth.

This contrast in the behaviour of the two phases also confirms the conclusion that the primary cause for the *initiation* of the reproductive phase is much more deep seated than mere balance in nutritional flow.

The periods for the subsequent successive incidences of reproductive growth after the appearance of the first reproductive phase remain constant for each interval in all the series, in spite of varying development and complete or partial shedding of flower buds and bolls. It is, therefore, concluded that the *initiation* of the reproductive phase introduces a *physiological inhibition* of growth activity, which is not wholly connected with the diversion of nutritional flow to the developing reproductive structures and which takes a definite amount of time to be washed off.

The number of times the reproductive growth occurs depends upon the total span of life determined by the downward gradient of the relative growth rate curve reaching the zero-line.

The final yields obtained per plant are the resultant effects of these growth variabilities in each phase of vegetative and reproductive growth.

33. The growth of the cotton plant in India—IV. The interpretation of varietal variability of growth in *Gossypium herbaceum* as compared with that of *Dhulia neglectum*.

R. S. INAMDAR *and* B. N. SINGH, Benares.

A study of varietal variability was undertaken with a view to estimate growth factors.

It is concluded at the outest that under the conditions in Benares in the season in which it was grown, *Gosseypium herbaceum* with a longer period of growth does not attain to the maximum possibilities of its growth potentiality.

The growth curves in all the series conform, in their general features, to those of *Dhulia neglectum* when allowances are made for the disturbances introduced. Thus all conform to the equation $\text{Log } W = n \log t + a$. The disturbances introduced by the appearance of reproductive phases are of the same nature, emphasising here also the physiological significance of the antecedent maximal hump in the growth rate curve on the subsequent initiation of the reproductive phase. The effect of the atmospheric conditions on the successive sowings of the crop are also of the same nature.

The plant does not grow successfully because the maximum growth potentiality of the plant never comes into full play. Consequently the slope of the growth curve is always less steep than that of the corresponding curves in *Dhulia neglectum*. This affects primarily the physiologically comparable magnitudes of dry weights produced by the plants at physiologically corresponding periods of growth as compared with the growth of the shorter variety. This is also the reason why a large number of reproductive initials fail to develop to maturity (with an increase in the number of flowers and bolls that shed) because the requisite physiological balance between the vegetative growth and the reproductive growth is not kept up.

It is suggested that the failure of the plant to bring its *full* growth potentiality into play is to be located in the relative efficiency of the transpiratory and assimilatory functions of the leaf in this variety.

Resistence to growth increases, on the one hand, as the sowing time advances towards the height of summer with its rising temperature, and, on the other hand, as the early growth of plants is overtaken by the continuous monsoon rains. The former influences the "predetermining" phase of growth and the latter the assimilatory intensity of the leaves for early dry weight production. The constructional difference in the leaves of this variety as compared with those of *Dhulia neglectum* appear to be responsible for both these differences; and an independent enquiry in this direction may prove profitable.

34. The growth of the cotton plant in India—V. The causal factors at work in the shedding of flowers and bolls (which determine final yield in cotton) in terms of the conceptions of dynamic equilibria in the co-ordinated growth activity of the entire organism in successive phases of growth.

B. N. Singh, Benares.

The preceding papers in this series of communications have established the view that growth magnitudes—whether vegetative or reproductive—have to be analysed in terms of the conceptions of dynamic equilibria in the *co-ordinated growth activities* of the plant in successive phases of growth. The influence of some of these growth activities is more deep-seated than others of the subsequent phases of growth. Nevertheless, the final results at any stage of growth are the resultant effects of a kind of integration of the previous happenings in the plant which lives in the present. In the present investigation this conception has been applied to the analysis of the important problem of flower and boll shedding in the cotton plant and of the final yields obtained.

Leaving apart parasitic pathology as an explanation of the shedding of flowers and bolls in certain instances, regarding the physiological aspects of the problem, recent work has rather tended towards concentration on isolated phenomena as causal factors, ranging from the shortage of water supply or nutritive material to the developing flowers and fruits, to the incomplete pollination or fertilisation of the flower, or even the osmotic changes in the critical condition of the flower. But no serious attempt has been made to apply the principles of dynamic conceptions of growth activity of the organism as a whole to the analysis of the problem.

The first striking result in this way of analysis is the close connection observed between the percentage of flowers which reach maturity in each variety and each series of sowings of cotton, and the degree to which the *full* growth potentiality of the plant comes into play as the visible manifestation of growth. Thus, for instance, *Gossypium herbaceum*, has to its credit cent. per cent. shedding of flowers and bolls in the IInd, IIIrd, and IVth series of sowings, while in *Dhulia neglectum*, the shedding is only 60, 70, and 40 per cent. of production in the corresponding series of sowings.

The results of the four series of sowings of *Dhulia neglectum* are a further illustration of the dependence of the number of flowers which reach maturity on the previous growth history of the plants. Thus, for instance, the shedding of bolls is 30, 60, 70, and 40 per cent. of production respectively in all the four series. These composite figures for the total growth period are remarkably correlated with growth variations in all the series in successive phases of growth described earlier (part II).

Some of these variations are deep-seated and are predetermined at the early seedling phase, while others are merely the temporary and superficial effects of the environment on the operation of predetermined factors in the plant in various directions, (Cf. series II and III). But in either case the end result in yield is the resultant effect of the dynamic relations of growth activities in different phases of growth.

The most convincing record of the existence of dynamic relations is obtained in the relations existing between the intensity of the maximal humps of the relative rate of growth antecedent to flower production in each series, and the total yield obtained from the subsequent crop of flowers. Figures are exhibited in this connection for each of the three phases of reproductive growth in both the short and the long variety series I.

Of the immediate antecedents to the shedding of flowers and bolls, the failure of the flowers to open has been noted prominently in the long variety, *Gossypium herbaceum*, series II, III, and IV, where cent. per cent. shedding of flowers and bolls occurs. The failure of the flowers to open may affect either the maturity of pollen or the cross fertilisation of flowers, factors which are known to cause flower and boll shedding.

Of the other immediate antecedent factors, the water-content of the tissues appears to be significant.

The dependence of the maturity of flowers and buds on the supply of nutritive material in the vegetative parts is evident from the many facts which are discussed above. The data connecting the total dry weights produced and the final yields of cotton per plant in all the four series of *Dhulia neglectum* are a gross illustration of what has been analytically discussed above in every phase of growth. Thus, for instance, the relations of final $\frac{\text{dry weights}}{\text{yields}}$ per plant are $\frac{44.18\text{ gms.}}{\substack{3\frac{3}{4}\text{ tolas}\\ \text{(average)}}}$, $\frac{29.88\text{ gms.}}{\substack{2\frac{1}{2}\text{ tolas}\\ \text{(average)}}}$, $\frac{24.33\text{ gms.}}{\substack{2\frac{1}{12}\text{ tolas}\\ \text{(average)}}}$, and $\frac{39.11\text{ gms.}}{\substack{3\frac{1}{3}\text{ tolas}\\ \text{(average)}}}$, respectively for the four series of sowings.

These immediate antecedents, which are all true, have loomed large in recent investigations, while the problem is really deeper than all of them put together. The problem of the shedding of flowers and bolls is the problem of analysis of growth variability in each phase of growth, which has been attempted in the study of the growth mechanism of the plant in parts I to IV of this series. If it is a phenomenon of physiological pathology of the plant, it is only in this sense; and its solution is the solution of how to bring the maximum possible growth potentiality of the plant into full play in each phase of growth.

35. A note on albino and mosaic characters in rice.

S. K. Mitra *and* S. N. Gupta.

The albino seedlings are found to appear in a number of apparently pure varieties both in autumn (short growing) and winter (long growing) paddy varieties. Their percentage ranges from 26% in Asra (winter paddy) to 20% in aus crosses.

An apparently pure sali type, S. 559, with green leaves has been found to produce green, mosaic (white-striped leaves) and albino plants in a 12 : 3 : 1 ratio, as it were. The mosaic plants originating from the above also give out mainly mosaic, albino and a very few green seedlings. Both the albino and mosaic characters are degenerative and lethal.

Attempts are being made to study the inheritance of same by hybridization.

36. Chlorophyll deficiencies in Sorghum.

G. N. Rangaswamy Ayyangar *and* M. A. Sankara Ayyar.

Five types of Chlorophyll deficiency in Sorghum are described and recorded as simple recessives to the normal healthy green.

37. A comparison of the progeny of (1) shrivelled wheat grains, and (2) normal plump wheat grains.

L. Jai Chand Luthra, Lyallpur.

In 1928, wheat crop in several parts of the Punjab was greatly damaged by adverse conditions and the wheat grain did not develop well and was shrivelled. In some cases the heads were found abortive and grain was not formed to the extent of 15–30 %. Germination capacity of the grain, though shrivelled, was found on testing to be pretty high. In over 50 samples it varied between 90-99 % and in most of the cases it was between 60 and 90 %. Samples from some bad fields, however, showed 20-50 % germination. As a result of these tests wheat grains though apparently imperfect and extremely small in size, were considered suitable for sowing purposes.

2. In 1929, experiments were laid down to compare the crop raised from shrivelled grains and normal plump grains. Five representative samples from different places were taken and the following results were obtained:—

The progeny of shrivelled grains showed a remarkable improvement over parent grains. Mean weight of 1000 grains had increased by 139.4 %. Specific gravity rose by 7.2 %; length was increased by 22.1 and breadth by 63.8 %. Consistency of the grain also had improved considerably. There was no sign of shrivelling and the grains were as plump as in normal condition.

AGRICULTURAL ENTOMOLOGY.

38. The Aleyrodidæ on Citrus and their control in the Punjab.

Mohammad Afzal Husain *and* Abdul Wahid, Punjab.

The following species of the Aleyrodidæ have so far been found on citrus trees in the Punjab:—

Dialeorodes citri Ashm.
Aleurocanthus woglumi Ashb.
Aleurocanthus spiniferus Q.
Aleurolobus marlatti Q.
Dialeurodes (*Dialeurolonga*) *elongata* Dozier.
Tetraleurodoides citriculus Dozier (mn.s.n.).
Aleuromigda dojhai Dozier and Baker (mn.s.n.).

Of these the three last named species are new to science and have been named from the collection sent from the Punjab.

Aleurocanthus citriperdus Q. and B. collected by Woglum from Lahore has not been so far obtained by us.

External anatomy, life-history, seasonal-history and distribution have been studied.

D. citri and *D. elongata* are the commonest and the most destructive in the Punjab. *A. spiniferus* causes serious damage to citrus trees in Lahore. *A. woglumi* is destructive in South-East Punjab.

Except *A. marlatti* and *T. citriculus* which are found on the upper as well as the lower surface of leaves, all the species confine themselves to the lower surface of leaves. The eggs are laid practically invariably on the lower surface of leaves and the nymphs settle there. The 'honey dew' which these insects produce falls on the leaves below, and on this the black mould appears. The infested trees thus look black.

Damage is caused by the nymphs sucking the juice, but more particularly through interference in photosynthesis caused by the covering of black mould on the leaves. There is however no external mark of injury such as spotting, discoloration, curling, or drying. The pest does not bring about the death of leaves or shoots. A severely infested tree does not bear fruit and if it does bear any the fruit is insipid.

The pests have been controlled by spraying.

39. The cotton white-flies (Aleyrodidæ) and the cotton failures in the Punjab.

MOHAMMAD AFZAL HUSAIN, Punjab.

Since 1919, there have been five more or less serious failures of the so called American varieties of cottons in the Punjab. During these years the *desi* varieties also suffered although not to the same extent as the Americans. The symptoms of the 'disease' may be described as follows:—

> The plants remain stunted, leaves begin to turn red from about the middle of October and excessive defoliation results, flowers and bolls are shed in large numbers, bolls remaining on the plants do not develop properly, remain soft and open prematurely and badly, lint is trash and seeds develop poorly.

By some investigators adverse environmental conditions such as drought, high atmospheric temperature, high soil temperature, etc. etc., have been held responsible for producing the above mentioned abnormal conditions. While others consider the white-flies the primary cause of the disaster. Roberts and Roger Thomas hold the latter view (Agric. Jl. India, XXIV, March, 1929), and Misra and Lamba follow them (Bull. 196 Agric., Res. Inst. Pusa, 1929). The conclusions arrived at are not supported by properly investigated facts.

Misra and Lamba have studied the white-fly and have named it *Bemisia gossypiperda*. Their statement that antennæ are absent in the second instar nymph must be challenged as it is incorrect. Their list of alternative food plants is also based on insufficient data, and is probably too exhaustive.

The attack on the cotton crop starts in May and continues to increase till the end of August and then it subsides. During this time both the *desi* and American varieties are attacked equally severely. There is no defoliation and no drying of the plants. Thus at the time when the attack is at its highest the plants continue to grow and there is no apparent sign of any disease, except shining appearance and stickiness on the leaves which are due to the 'honey-dew' dropped by the insects. Later on black mould appears on this honey-dew and the lower leaves of an infested plant get covered by this black stuff. There is no spotting, discoloration, distortion, crumpling or withering of leaves, and there is no other sign of abnormal condition.

There is hardly any doubt that a plant which provides food to the numerous sucking insects cannot be normal, and the black fungus developing on the upper surface of leaves does certainly interfere with photosynthesis and checks normal respiration, as a large number of stomata are situated on this surface. All the same this interference with the functions of the leaves is not such as to produce the 'disease.'

Cases have been known where fields badly infested with white-flies have not shown the 'disease,' and conversely fields which have shown the 'disease' have been free from or very slightly attacked by the white-flies.

This year the white-fly attack was very serious right up to the end of August and yet the 'disease' has not appeared. It has been noticed that in the same fields plants which are vigorous and healthy have a larger number of white-flies on them than plants stunted and sickly. Plants grown under cages although heavily infested with white-flies do not show any of the symptoms of the 'disease.'

The disease of cotton, therefore, which brought about the failures of the American cottons in the Punjab is independent of the white-fly attack. It is of utmost importance for the future of cotton growing that this fact is recognized.

40. Insects associated with South Indian Coccidæ and their economic importance.

T. V. Ramakrishna Ayyar, Madras.

The paper begins with a very brief summary of such of the salient features of the Coccid insects which have a bearing on their insect associates, gives a short account of the chief characteristics of Coccid associates in general, lists the known associates of South Indian Coccidæ with their respective categories and concludes with some remarks on the significance of such associations and their economic value, with special reference to South Indian forms. The main idea of the paper, which includes only a brief summary of the author's preliminary studies in this line, is to invite the attention of other workers to the importance of the study of insect ecology—an aspect of entomology which is not only of absorbing interest to the pure scientist, but is pregnant with economic possibilities for the farmer or horticulturist.

41. The life-history of the Jasmine bug—*Antestia cruciata.*

T.. K. Venkatakrishnan, Hyderabad (Deccan).

Antestia cruciata Fb., (Fam. Pentatomidæ)—also known as "The Coffee berry bug," has been recorded as a serious pest of Coffee in Ceylon and in the Coffee areas of South India. In the plains, on the other hand, it is more familiarly known as a serious pest of Jasmine, reports of damage having been received from the districts of Bellary, Anantapore, Salem, and North Arcot.

Eggs are laid in clusters of 7 to 13, generally on the lower surface of leaves. The life-cycle covers about 30 days on the average under artificial conditions in cages. The adult appears to be fairly long-lived, periods of 6 to 7 weeks having been recorded in cages. The greatest damage is done by the adult bugs, the shoots and flower-buds being punctured and caused to fade and wither. In instances of bad attack, a loss of 40% to 50% of the yield of flowers—amounting in money value roughly to a loss of Rs. 300/- to Rs. 400/- is not uncommon. As regards control methods, the 'tent-system of calcium cyanide dusting' has been found to be very effective.

42. The biological control of the fluted scale—*Icerya purchasi*—in South India.

Rao Sahib Y. Ramachandra Rao, Coimbatore.

In April, 1928, a report was received regarding serious damage by the fluted scale on a Wattle plantation at MacIvor's bund on the Nilgiris.

On investigation, the scale was found already widely distributed in several places on the Nilgiri plateau, such as Fairlawns, Keti, Wellington, and Coonoor. Besides the Wattle—*Acacia decurrens*—, about 20 other plants, including the wild wattle—*Acacia dealbata*, the Broom, St. John's Wort, Gorse, Roses, and the Potato Creeper, were also found attacked. At Keti, the infestation was evidently already three years old. It is considered almost certain that the scale must have come in through the medium of imported orchard stock. As a preliminary measure, cutting and burning of infested brooms was done at Fairlawns, in order to prevent a further spread of the pest.

The effective control of this serious pest in 1888, in California by the importation of its natural enemy—the Vedalia beetle—from the original home of the Scale—Australia, is now become a classic in the history of economic entomology. The same method has since been successfully applied in various countries which the scale has invaded, the latest example being Ceylon. The Entomologists of many of these countries—Ceylon, Java, South Africa, Rhodesia, Kenya, Egypt, Queensland, New South Wales, Victoria, South Australia, and last but not least the Imperial Bureau of Entomology, London, were approached for supplies of the Vedalia beetle. South Africa kindly responded with a consignment shipped direct to Madras in April, 1929; unfortunately, however, the contents were found dead on arrival. A second consignment shipped to Colombo by Dr. Thompson of the Farnham Royal Laboratory—obtained by him from California—was received in May, 1929. When opened out, three beetles and a dozen grubs were found alive, and these were promptly transferred to a special breeding laboratory opened at Keti. From the scanty supply received, however, the writer is happy to state that the beetles have bred satisfactorily, so that there were 10,000 individuals in various stages in stock in August. Liberation of beetles in the various centres of infestation has now been taken in hand, and it is hoped that the scale would very soon be brought under control.

43. Ants and the lac insect.

P. S. NEGI, M. P. MISRA *and* S. N. GUPTA, Namkum.

The paper deals with eight more species of ants other than hitherto recorded associated with lac and their relation to the lac insect. Methods of control against the injurious species of ants are given.

44. Seasonal variations in the host-plants of the lac insect.

S. RANGANATHAN.

The paper gives the results of periodical analysis of Kusum and Ber, two of the principal host-plants of the lac insect, and an attempt is made to correlate the seasonal changes in composition with the stages in the life cycle of the lac insects parasitic on them and the annual vegetative cycles of the hosts.

Although in general the nutritive constituents in the hosts increase with the onset of spring and again during the rains in the case of Ber and a month or two later in the case of Kusum, particular importance is to be attached to the amounts of phosphorus, water-soluble solids and alcohol-soluble minerals present in the plants since the variations in these constituents synchronise with the periods of active resin production though the crop seasons are different on the two hosts.

45. A note on the pruning of lac hosts.

M. VENUGOPALAN *and* M. RANGASWAMI.

After discussing the general principles involved in all pruning operations, the paper deals with the importance of systematic and timely pruning of lac hosts for the successful propagation of lac. The dependence of methods and times of pruning on the species of host plant, age, climate and locality is indicated and the necessity of making adequate provision for proper sunlight and ventilation is emphasised.

The results of pruning experiments with three hosts like *Butea frondosa, Zizyphus jujuba* and *Acacia catechu* have been described and photographs taken wherever possible.

In addition, the paper describes the results of four distinct types of pruning instituted in the experimental plantation at Namkum with the view to study (*a*) the effect on the vitality of the plant, (*b*) the number and nature of shoots produced, (*c*) the shape the plant would assume, at the end of a few years' systematic pruning.

46. A preliminary note on the nutrition of the Lac insect.

S. RANGANATHAN.

Different methods of solving the problem of the nutrition of the lac insect, some of which have already been adopted by previous workers in the field, are outlined.

Analyses have been carried out of the insects at their larval and mature stages and of two adjacent Khair plants (*Acacia catechu*) one of which was under lac crop while the other served as control.

From the results obtained it would appear that starch water-soluble-nitrogen and minerals and total phosphorus play an important part in the nutrition of the insect.

AGRICULTURAL MYCOLOGY AND BACTERIOLOGY.

47. Studies on "powdery mildews" and "rusts" of cereals and the means of combating them.

K. C. MEHTA, Agra.

The writer has studied the incidence of "mildews" and "rusts" of cereals between the harvesting and the sowing periods during the last six years.

A brief account of the work on rusts of wheat was presented last year in the presidential address to the Botany section of the Indian Science Congress at Madras.

In the present paper the writer proposes to submit the proposed measures of control for a discussion which was not possible last year. Mildews and rusts of cereals have been observed growing on "self sown" plants in the hills during the critical period—May-October by the writer every year during the last six years.

The idea of mildews and the uredospores of rusts obtained from "self sown" plants showed a high percentage of viability and produced successful infection in artificial inoculations.

The occurrence of mildews and rusts under identical conditions offers a unique opportunity for control of as many as seven pests—four of wheat and three of barley.

Destruction of self-sown plants after the harvest and again before the sowing period should materially reduce the damage done by these parasites.

Suspension of the cultivation of wheat and barley for two or three years at such localities in the hills where the parasites can survive the summer should prove a very effective check and may eradicate the pests altogether.

48. A Bacterial stalk rot of Maize plants.

HARI HAR PRASAD.

Appearance of a bacterial stalk rot in maize round about Pusa in 1928 and 1929 has been noticed. Isolation of an organism and inoculations and cross inoculations with it prove its pathogenicity. It has the same cultural characters as an organism named *Phytomonas dissolvens* by H. R. Rosen of the Arkansas Agricultural Experiment Station who found it causing a similar disease in Arkansas. It was noticed also in some other States of America.

49. The use of small additions of acid for increasing the germicidal action of E.C. on bacterial spores.

C. S. RAM AYYAR, Pusa.

Tests made with the spores of various soil bacteria showed that they are not destroyed completely by E.C. (Hypochlorite) in a dilution of 1 in 500 even after 60 minutes contact in water of P_H about 7.0. If, however, a small amount of acid, viz., 0.05 per cent. normal citric acid solution corresponding to 3.5 grams of citric acid per 10 litres (P_H 3.9) be added to the diluting liquid before the addition of E.C., the germicidal efficiency of the latter is increased considerably and practically complete destruction of the spores takes place after 30 minutes' contact.

The practical value of these tests lies in the fact that silk house nurseries can be disinfected with greater certainty with E.C. in a dilution of 1 in 500, if to the diluting liquid a small amount of acid is added.

50. A simplified method of hot water treatment against loose smut of wheat.

KRIPA RAM MOHENDRA.

The writer describes a series of experiments on the control of loose smut of wheat. A simplified method of treating seed wheat against smut which has been standardized for Punjab conditions is given The new method makes use of a range of temperature (127–131°F) instead of a point of temperature (129°F) as was done hitherto. A hot water treatment equipment which has been devised and standardised for carrying out the treatment is described.

51. Virus Diseases of the Potato in the Punjab.

KRIPA RAM MOHENDRA.

A study of the causes of the low yields of the Potato crop in the Punjab has revealed the prevalence of virus diseases—mosaic and leaf roll of the Potatoes Macroscopic symptoms of these diseases as found under Punjab conditions are described in detail. The writer describes his observations on one hundred diseased and healthy potato plants during the winter 1928–29 and states that these observations lead him to conclude that serious losses are being caused to the potato crop in the Punjab by virus diseases.

In other potato growing countries similar diseases of the potato have been controlled by roguing out infected plants from seed plots. A similar line of treatment is suggested for the control of these diseases in the Punjab.

AGRICULTURAL ENGINEERING.

52. Observations on the economics of threshing.

C. Maya Das, Cawnpore.

1. Brief history of threshing experiments conducted and reported so far—1907 to 1929.
2. Details of recent experiment on threshing at Cawnpore.
3. Possibilities attending the introduction of modern threshing machinery driven by a motor tractor.
4. Some additional advantages of modern threshers over the country method of threshing.
5. Summary of observations.
6. Bibliography.
7. Statements I to IV of Appendix.

53. Agricultural engineering research in India.

Mason Vaugh.

Agricultural engineering research in India has been largely restricted to problems of water supply. In this, brilliant work has been done. The more distinctively agricultural problems have so far received little attention and the little they have had has been from men not really trained for the purpose.

Only three agencies are available for research, the agricultural engineers to Government, the engineering staffs of Agricultural Colleges and implement manufacturers. Private enterprise not connected with one of these agencies cannot be depended on for any large contribution.

The first and most fundamental problem in such research is trained personnel. Splendidly trained engineers knowing nothing of agriculture cannot be expected to make the same contribution that they could with agricultural training added. To be most effective, they must be trained not only in both subjects but in the co-ordination of them as well.

Research in agricultural engineering must go beyond testing of competing types of equipment back to the fundamental basis of the problems. We must know what we want to accomplish, have standards and methods of measuring our accomplishments and be able and willing to adopt and adapt new methods where old methods fail to give the desired results.

There are three main groups of problems to be met. The first has to do with all phases of working the soil in the preparation of seed beds, in interculture, and in the handling of irrigation water in the fields. The second has to do with the problems of dressing and harvesting crops. Harvesting methods are antiquated but we are seriously handicapped in introducing western methods since conditions are so different. The problems of threshing, bhusa making, rice hulling, and other crop dressings are in urgent need of attention. The third group of problems is that of farm or rural building. This should include not only the farmer's home but the whole village, his cattle and his supplies of food grains and seeds. Any one of these groups of problems is enough to demand the attention of many workers for some time.

The agencies at work in this direction are few and the workers scattered. Co-operative effort will enable us to get on with the work much faster. There are problems enough for everyone and we should not be afraid to consult others and to take their help and suggestions in planning our work.

54. Electricity and agriculture.

T. J. MIRCHANDANI.

This short paper is a continuation of the one on the same subject read at the last Calcutta session.

In spite of the opinion of the Royal Agricultural Commission, the author feels that the employment of electricity on the farm is not such a remote possibility—*vide*, the phenomenal development in this direction in France, Scandinavia, America, New Zealand, and even England. This is mainly to be attributed to power being available, almost at the doorstep, from lines traversing the country. These conditions, it is hoped, will be reproduced in several parts of this country by schemes of hydro-electric development, specially in the U.P., Punjab, and Madras.

A cheap and reasonably safe system of obtaining electric power from the high voltage lines is outlined and its cost worked out for existing conditions in this country. Experience gained by various countries regarding the most suitable size of motors for different duties, systems of wiring, and distribution of load, etc., is summarized and examined.

Mention is made of the methods of co-operation and hire-purchase in vogue in certain countries, and the enormous field for their application offered by this country, is pointed out.

ANIMAL NUTRITION.

55. A short resumé of some aspects of the work of the nutrition section at Bangalore

A. VISWANATHA IYER, Bangalore.

The work at present is confined mostly to the nutrition of farm animals.

1. This necessitates the determination of the feeding values of coarse fodders and the more important concentrates. To obtain these values digestion experiments have been carried out with (1) rice straw, (2) ragi straw, (3) several types of hay sent from the Military Farms Department, (4) spear grass, (5) jouar, etc. This work enables us not only to obtain the feeding values of the samples under examination and their comparison, which of course is very important, but also the starch values for our fodders.

2. The work as a matter of course also necessitates the chemical and physiological examination of fodders and the metabolised products in faeces and urine. In the matter of examination of fodders a study of the several changes involved in silage and hay making which are the most commonly accepted forms of preserved fodders is also undertaken. This again brings us to the necessity of studying the best times for cutting a crop for hay of silage making with a view to utilise same in the most economical way.

56. Feeding experiments with young stock by the nutrition section.

T. S. KRISHNAN.

The primary objective with which growth in young stock is studied by the nutrition section of the Imperial Department of Agriculture is to get the comparative values of different fodders for growth production under various conditions.

Experiments have been conducted at various places with a number of growing animals using different fodders and animals and extremely important results have been obtained.

Besides the above another objective, though till recently considered secondary, yet of much greater intrinsic importance, which is kept in view in all these experiments, is to determine the starch equivalents of Indian fodders, when fed to Indian cattle under local conditions.

The starch equivalents computed by European workers for different feeding stuffs are assumed and long period feeding experiments conducted and the actual growth obtained compared against the growth computed from the values assumed. The results enable the checking, correcting, and establishing of accurate starch equivalents for the feeding stuffs used.

The work has only been begun and valuable data are being obtained as the result of a series of carefully planned experiments with various fodders.

57. Effect of maturity on the nutritive value of fodders.

A. Viswanatha Iyer.

Jouar and a sample of grass supplied by the military grass farm from a uniform plot at Bolarum were the samples selected for this series of experiments. Both were examined at three stages of development, viz., young, prime, and ripe.

In the case of Jouar, digestion experiments were carried out both on the freshly cut material and the same material converted into hay.

With the grass, only hay made out of it was experimented with.

From the figures obtained, it can be seen that nutritive value decreases as maturity advances. This will enable us to point out the best time for cutting a crop and of utilising same in the most economical way.

Further work on this subject is in progress.

58. Silage investigations at Bangalore.

T. S. Krishnan.

Numerous experiments conducted by the nutrition section of the Imperial Department of Agriculture on young stock have shown the advantage of using silage for growth production.

Digestion experiments with silage have repeatedly yielded a low digestion co-efficient for the protein and a high figure for the fibre.

Experiments have been started with a view to elucidating the reasons for such behaviour.

Preliminary experiments on silage have disclosed an actual loss of protein during the process of ensilage.

The depression of the protein digestibility on ensilage might reasonably be attributed to the destruction of the most easily digestible portion of the protein in the plant during the ensilage.

The high efficiency of silage must probably be due to easier availability of the silage carbohydrates.

The problem is being investigated.

The high efficiency of silage might also be due to the presence of easily assimilable minerals.

GENERAL PAPERS.

59. Storage of potatoes.

N. D. Vyas.

The author deals with the experiments conducted by him on the storage of potatoes and recommends a method by which without periodical examination cultivators can keep a stock of seed potatoes for a period of six to seven months, till the next growing season, with a loss varying from 3·6 to 7·5 per cent.

The recommendations consist in harvesting potatoes early in the season, end of February being suitable for places around Pusa, drying for about a fortnight under shade, selecting the medium sized sound tubers and their storage in cinders lime mixture or charcoal in dealwood boxes.

60. The improvement of the economic relations between landlord and tenant in the United Provinces.

C. MAYA DAS, Cawnpore.

(1) Introductory: briefly reviewing literature on the subject. (2) Objects of experiment at Cawnpore. (3) Brief account of the experiment. (4) Brief summary of results so far obtained. (5) General observations. (6) Conclusions arrived at. (7) Bibliography.

61. Notes on some rats damaging crops in South India.

P. N. KRISHNA AYYAR, Madras.

It is universally recognised that there are few animals that cause, by their depredations, greater loss to man than those belonging to the group popularly known as rats. On account of their numerical strength, wide distribution, their great fecundity and adaptability to varying conditions and omnivorous feeding habits these have certainly attained unenviable notoriety all over the world. But it is only recently, comparatively speaking, that the highly important role played by them in the destruction of crops has come into prominence. The destruction caused by these to crops is undoubtedly frightful, the loss sometimes amounting to nearly fifty per cent. of the gross outturn.

There is practically very little on record regarding the species that damage crops, their habits or methods of control except the very brief and passing reference made by Fletcher in his excellent book on some South Indian Insects. Therefore this paper, so far as the writer is aware, is perhaps one of the first if not the first venture in this direction in South India.

The paper is designed to give a brief account of the biology, habits, and habitations of some of the most destructive species such as the Southern mole rat *Gunomys Kok*, the soft furred mole rat *Millardia meltada*, the common Indian rat *Rattus rattus wroughtoni*, etc., which frequent and breed in cultivated areas, noted by the writer in South India, together with some notes on the nature and extent of damage caused to such valuable crops as rice, ragi, and other grain crops, cotton, coconuts, tea, etc. A brief reference to the various localities where such ravages have been so far noted in South India is also made. In order to impart a sort of completeness to the subject dealt with a short account of the various control measures is also added with special reference to poison baiting and fumigation that have been given a fair trial in South India.

62. The effect of soaking maize in water before sowing.

B. S. SAWHNEY.

It was decided in July, 1928, to study the effects of soaking maize in water before sowing. The advantages of soaking the seed for 8 hours and 12 hours over the unsoaked was studied. It was found that the soaking accelerated the speed of germination and soaked seed could be sown with a lesser amount of moisture in the soil than the unsoaked which was used as a control. It is interesting to note that the best results were obtained with the 8 hours soaking.

This experiment was repeated again in 1929 but this year the advantages of soaking for 4, 6, 7, 8, 9, 10, and 12 hours over the control were studied. The results in 1929 were not up to our expectations due to rains just after the sowings were completed. However, they confirmed our last year's results.

This soaking of seed before sowing will enable the cultivator, who depends on the rains to do his showing to make use of the early showers which are not usually very heavy and thus not only get a higher acreage under the crop per plough but also an increase in the field per acre due to the longer growing period of the crop.

Section of Mathematics and Physics.

President:—PROF. B. VENKATESACHAR, M.A.

Presidential Address.

THE FINE STRUCTURE OF SPECTRAL LINES IN RELATION TO SELECTIVE ABSORPTION.

GENTLEMEN,

Let me at the outset thank you for the honour you have done me in asking me to preside over the meeting of the Mathematics and Physics Section of the Science Congress this year. It is an honour that I deeply appreciate.

I have chosen for the subject of my address 'The Fine Structure of Spectral Lines in Relation to Selective Absorption'. In this choice I have been guided by the idea that, while important, it should be one of which I have personal experience. It is needless to stress the importance in modern physics of the study of the fine structure (or as it is sometimes called the hyperfine structure) of spectral lines It is enough to remember in this connection that, quite recently, Back and Goudsmit,[1, 2] from a study of the fine structure components of bismuth lines and their Zeeman Effect, have drawn the very interesting conclusion that the nucleus of the bismuth atom has a spin with an impulse moment of $4\frac{1}{2} \cdot \frac{h}{2\pi}$ while Jackson[3] from a study of the lines of the principal series of Caesium infers that the nucleus of the Caesium atom has a rotation with an impulse moment which may be $\frac{1}{2}$ or $1\frac{1}{2} \cdot \frac{h}{2\pi}$.

The cases in which the origin of fine structure has been understood are few compared with those still awaiting elucidation. Ever since Michelson showed by his ingenious study of the visibility curves in his interferometer, that, very often, a line which appears single in a spectroscope of low resolving power, is really a group of lines with minute differences of wavelength, a large number of investigators have studied the fine structure of spectral lines with improved instruments of high resolving power familiar to modern students of optics. Much as the experimental work already done in this line has been, an enormous amount still remains to be done before a theoretical structure accounting for all fine structure can be

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[1] Back and Goudsmit. '*Z. Physik*', Vol. 43, pp. 321–334 (1927).
[2] ,, ,, ,, ,, Vol. 47, pp. 174–183 (1928).
[3] Jackson, *Roy. Soc. Proc.*, A, Vol. 121, pp. 432–447 (1928).

built. In many cases, the data already available have to be checked by further experimental work. A lack of adequate appreciation of the influence of selective absorption on the fine structure patterns of lines in instruments of high resolving power has resulted in the representation of many a line as more complex than it really is. Wood has shown that the first resonance radiation of mercury, 2536 Å. described by Nagaoka and his collaborators as a group of 25 lines is really made up of but five components of nearly equal intensity. On the other hand, there are instances of a really complex line exhibiting little or no selective absorption, being represented as a simple line, for want of a suitable source. The mercury line 4916 ($2^1P_1-3^1S_0$) has been described by skilful observers like V. Baeyer, Janicki, and others as a simple nebulous line unaccompanied by satellites. Quite recently I have examined this line with two quartz Lummer-Gehrcke plates and a suitable source and find that it is a group of six or even seven components. On the longer wavelength side of the main line and quite close to it is the brightest of the satellites which has escaped observation.

CHOICE OF SOURCE.

The conditions which all sources should satisfy are low density and absence of strong electrical excitation. In addition the element under examination must be pure except, of course, in cases in which the effect of a foreign substance on fine structure is itself the subject of enquiry. It is well known to investigators in this field that traces of impurity often modify the structure of lines preventing the appearance of satellites which show up when the substance is pure. The further choice of a suitable source depends on whether the line under examination exhibits strong selective absorption or not. In the same spectrum different lines behave differently in respect of selective absorption, not merely depending on the concentration of the corresponding absorbing centres, so that a source designed to suit the analysis of one line may not do for the examination of another. The two mercury lines already referred to, *viz.*, the resonance line 2536 ($1^1S_0-2^3P_1$) which exhibits strong selective absorption and the line 4916 ($2^1P_1-3^1S_0$) which exhibits little or none are striking instances in point.

SELECTIVE ABSORPTION OF SPECTRAL LINES.

Before discussing the influence of selective absorption on fine structure patterns it is desirable that we take a survey of the information available in the field of selective absorption of spectral lines considered as unresolved units, for, as we shall see, the behaviour of a satellite in regard to this property generally depends on the behaviour of the line as a whole to which it belongs. Prior to the advent of Bohr's theory of spectral radiation experimental work in this field was mainly directed to the detection of selective absorption in luminous flames and electrically excited gases and in cases in which a quantitative study was attempted the object kept in view was to test whether the laws of temperature radiation were obeyed by the luminous sources employed. Bohr's theory gave a new and experimentally fruitful orientation to the whole subject by its postulate that the molecules and atoms in a luminous source are in several discrete states with different energy contents and that absorption is the transition of a centre from a lower energy state to one of higher by the incidence of the appropriate light quantum. That the unexcited vapour of an alkali metal absorbs lines of the principal series but not those of the subordinate series and that hydrogen must be made electrically luminescent before it can absorb the Balmer lines, facts puzzling from the classical viewpoint, received a simple and now familiar explanation. One effect of this explanation was that experimental work on the selective absorption of unexcited vapours of elements was carried out by several investigators with the object of determining the lowest optical atomic levels. It may be stated as an experimentally ascertained fact that there is marked absorption of radiations corresponding to transitions of the atom from the ground level to higher levels provided the selection rules are obeyed. The experimental character of this law needs emphasis for a large concentration of atoms in the state of lower energy content corresponding to the emission of a known line is not necessarily an indication that the line is markedly or even appreciably absorbed by the gas.

ABSORPTION BY LUMINOUS VAPOURS AND GASES.

In the photometric study of selective absorption by luminous mercury vapour carried out by Dr. Metcalfe and the present writer[1, 2] the absorption tube was designed so as to make the radiation from it negligible in comparison with that from the source. The device employed was to produce two arcs in the same enclosure with a common cathode, one carrying a comparatively heavy current and the other a feeble current ranging from 0 to 100 milliamperes in a long tube kept warm at a steady temperature by a current-carrying wire wound round it. When the dependence of selective absorption on the current density in the absorbing column is the subject of investigation, it is essential that the density of the vapour in the absorbing column be kept unaltered when the current in it

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[1] Metcalfe and Venkatesachar, *Roy. Soc. Proc.*, A, Vol 100, pp. 149–166 (1922).

[2] ,, ,, ,, Vol. 105, pp. 520–531 (1924).

is varied. In the apparatus under reference the power developed by the small currents sent through the long absorption tube was so small as compared with that developed by the main arc and the heating coil, that the temperature inside remained unaltered throughout a set of observations in which the current in the absorbing column was varied from 0 to about 100 milliamps. This conclusion was confirmed by the indications of thermocouples employed for the purpose. The radiating source was an independent arc run under known steady conditions of excitation.

EXPERIMENTAL RESULTS: ARC SPECTRUM OF MERCURY.

(*i*) The lines of the triplet series 2^3P_{012}—m^3S_1 and 2^3P_{012}—m^3D_{123} are most heavily absorbed. To the series $2^3P_{012}-m^3S_1$ belong the prominent visible lines 5461 (green), 4358 (indigo) and 4047 (violet).

(*ii*) The yellow lines 5791 (2^1P_1—3^1D_2) and 5769 (2^1P_1—3^3D_2) exhibit considerable absorption under suitable conditions and can be reversed by passing the radiation from a high density arc through an absorbing column.

(*iii*) The absorption of other lines has not been observed and if it exists must be comparatively very small.

(*iv*) Of two lines whose absorbing centres are in the same state of excitation one may be heavily absorbed while the other may exhibit little or no absorption.

Turner and Compton[1] investigated the selective absorption of mercury vapour rendered luminous by the electron current from a hot tungsten cathode and their results generally confirm the above conclusions. They, however, state that they did not observe any absorption of the yellow lines 5790 and 5769 whose absorbers are mercury atoms in the state 2^1P_1. It emerges from their work that in a series the absorption diminishes as we move up towards the higher members. M. Ponte[2] in a recent paper on the subject records his observation of the absorption of the yellow lines, in agreement with the result obtained by Metcalfe and Venkatesachar.

SELECTIVE ABSORPTION OF ELECTRICALLY LUMINESCENT CADMIUM VAPOUR.**

Recently I have studied the selective absorption of electrically luminescent cadmium vapour. It is not easy in the case of this element to produce a long absorbing column of cadmium vapour at a low pressure (of the order of 1 mm.) made faintly luminous by a steady arc discharge carrying a low current.

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[1] Turner and Compton, *Phys. Rev.*, 25, p. 606 (1925).

[2] *Comptes Rendus*, 187, pp. 37-39 (1928).

** Indicates author's work published for the first time.

There is also the difficulty of securing a suitable source. The usual form of cadmium arc lamp is of no use for this purpose as the emitted lines are too wide and frequently self-reserved on account of the high density of the metal vapour inside. There is the same objection to the radiation from the spark between cadmium electrodes. In the following arrangement (fig. 1) the main arc carrying a current of 3 amperes produced between the tungsten anode A^1 and the cadmium cathode B served as the source. AB was 5 cms. long with an inside diameter of 9 mm. The portion of the tube BC 15 cms. long and 16 mm. in bore through which an arc discharge carrying any desired current from 0 onwards could be passed, served as the absorbing column. One feature of the arrangement needs to be emphasised: the cadmium in the side tube BK which formed the common cathode to the main arc AB and the branched arc BC, as also the metal in the side tube CA$_2$ which formed the anode of the branched arc were throughout in the solid state. The pressure of the cadmium vapour in the region of discharge was therefore less than a millimetre. The whole tube was constantly kept pumped out by a Hy-vac. pump. The radiation passed through a fused silica plate P to the observing optical system. The illumination from the absorbing column BC carrying comparatively small currents (of the order

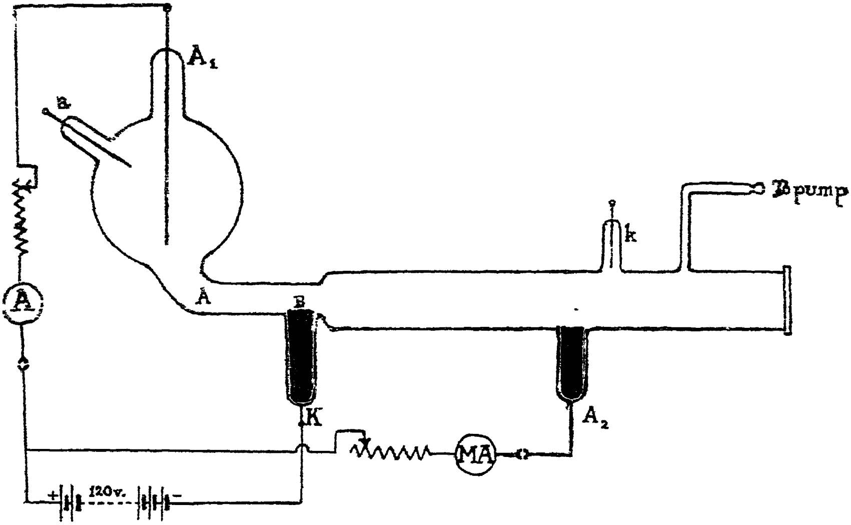

FIG. 1.

Selective absorption by electrically luminescent cadmium vapour.
Arrangement of Apparatus.

AB Main arc .. Source.
BC Branched arc .. Absorbing column.

of $\frac{1}{4}$ ampere) was negligible as compared with that from the source AB.

The following is an analysis of the results obtained :—

		Absorption.
(1) $2^3P_{012}-m^3S_1$		Strong.
4678 4800 5086	$2^3P_{012}-2^3S_1$	
3081 3133 3252	$2^3P_{012}-3^3S_1$	Marked.
2734 2775 2868	$2^3P_{012}-4^3S_1$	Slight.
(2) $1^3P_{012}-m^3D_{123}$		Strong.
3610 3613 3614	$2^3P_2-3^3D_{123}$	
3466 3468	$2^3P_1-3^3D_{12}$	
3404	$1^3P_0-3^3D_1$	
2982 etc.	$2^3P_{012}-4^3D_{123}$	Marked.
2764 etc.	$2^3P_{012}-5^3D_{123}$	Slight.
(3) $1^1P_1-m^1S_0$		
5155 4307	$2^1P_1-3^1S_0$ $2^1P_1-4^1S_0$	Not perceptible.
(4) $1^1P_1-m^1D_2$		
6438	$2^1P_1-3^1D_2$	Strong.
4663	$2^1P_1-4^1D_2$	Slight.
(5) $2^3P_1-2^1S_0$		
4413		Not perceptible.
(6) PP^1 multiplet.		
2240 2267 2306 2330		Strong.

(7) The line 2265 ($1^2S_1-1^2P_1$) of Cd II not absorbed.

It will be seen from the above analysis (*i*) that, as in the case of mercury, lines of the diffuse and sharp triplet series with absorbing centres in the states 2^3P_{012} exhibit the most marked absorption, and (*ii*) that, in a series whose lines are absorbed the atomic coefficient of absorption diminishes progressively as the current term number increases. 6438 the fundamental line of the international system of wavelengths, is more heavily absorbed than the corresponding mercury line 5790. The next member of the series 4663 is slightly but distinctly absorbed. The line 5155 (2^1P_1—3^1S_0) whose absorbing centres are the same as those of 6438 and 4663, suffers no absorption. The PP^1 multiplet lines involving double electron transition exhibit heavy absorption though lines comparatively more intense suffer none.

NEON.

Meissner[1] has made a careful study of the selective absorption of 26 emission lines of neon by passing the radiation from the capillary of a neon discharge tube through another wider tube also containing neon but feebly excited.

HELIUM.

McCurdy[2] has examined the selective absorption by luminous helium by observing the reversal of the lines produced by the passage of the radiation through a length of feebly excited gas contained in a wider part of the same discharge tube. He finds that lines of the principal and diffuse series in both the singlet and doublet systems are absorbed but the absorption of the lines of the sharp series is not perceptible.

THEORETICAL CONSIDERATIONS.

The coefficient of absorption, $\underline{a}$, is controlled by two factors: (*i*) the concentration of the atoms in the corresponding lower energy state, (*ii*) the atomic coefficient of absorption $C_{1\rightarrow 2}$ which solely depends on the initial and final states 1 and 2.

$$a = C_{1\rightarrow 2}N^1$$

The concentration N_1 depends on various factors such as the energy required to put a normal atom in the initial excited state when the absorbers in question are not atoms in the normal state, the mode of excitation adopted, the mean free life of the excited atom and the density of the gas. In the usual modes of excitation adopted in absorption experiments it is difficult, nay, well nigh impossible, to make a reliable quantitative estimate of the relative abundance of atoms in any given excited state. It is therefore necessary to concentrate our attention on lines whose absorbing centres are in the same excited state, if we wish to derive any reliable information in regard to the factor $C_{1\rightarrow 2}$. An examination of the experimental results so far available leads to the following conclusions :—

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[1] Meissner, *Ann. d. Phys.* 76, p. 124 (1925).
[2] McCurdy, *Phil. Mag.*, Vol. 2 (7), p. 529 (1926).

(1) That, in a series exhibiting selective absorption, the atomic coefficient of absorption is greatest for the first member and diminishes as we pass on to higher members.

(2) Of two series with the same absorbing centres, (*i.e.*,) with the same first term, the lines of one may be markedly absorbed, while the lines of the other may suffer little or no absorption.

Some striking cases illustrating (2) may be mentioned. Taking first the arc spectra of mercury and cadmium we find that both the diffuse and sharp triplet series with absorbing centres in the excited states 2^3P_{012} are heavily absorbed while the lines 4078 and 4413 of mercury and cadmium respectively of the series 2^3P_1—m^1S_0 suffer no perceptible absorption under the most favourable circumstances. In the case of singlets, lines of the diffuse series to which the yellow line 5790 of mercury and the important red line 6438 of cadmium belong, are markedly absorbed while those of the sharp series for instance, 4916 (2^1P_1—3^1S_0) in the case of mercury and 5155 (2^1P_1—3^1S_0) and 4307 (2^1P_1—4^1S_0) in the case of cadmium, with the same absorbing centres (2^1P_1), suffer no perceptible absorption. Using a branched arc nearly a metre and a half long as the absorbing column I could perceive no absorption of the mercury lines 4078 and 4916. The following law is deduced from an examination of the available experimental data on selective absorption by electrically luminescent gases and vapours :—

** "If the lines of a series corresponding to the transition A→B in absorption are heavily absorbed, A and B representing the sequence symbols of two sets of Rydberg sequences each with its characteristic azimuthal and inner quantum numbers, the lines of a series corresponding to the transition B→A in absorption suffer comparatively little absorption ; also, arranging the terms in the order of increasing energy content the first member of the sequence A will be below the first member of the sequence B."

This rule may be illustrated with the aid of the following diagram :—

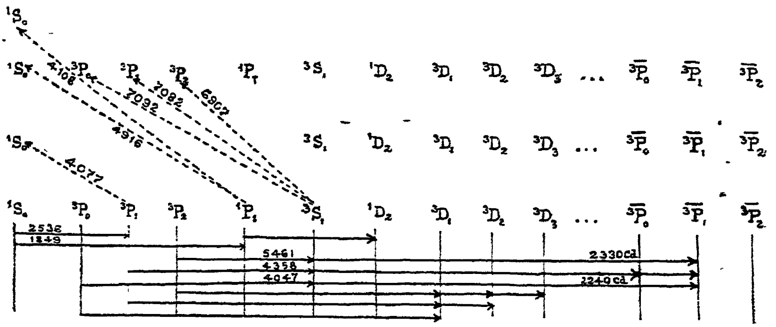

FIG. 2.

Diagram illustrating law.

Dotted lines indicate little absorption and full horizontal lines indicate marked absorption.

The first row from the bottom contains the first members of the several sequences in the arc spectrum of elements with 2 '*s*' electrons in the outermost shell of the atom in the normal state, the second row the second members, and so on. Starting from any term in the first row, say $^3P_1$, the transition from it in absorption to a term on the right, say $^3S_1$ in the same row or a row above, if permitted by the selection rules, corresponds to marked absorption of the particular radiation, whereas a transition from the same term to a term on the left in a row above corresponds to relatively little absorption. For instance, the mercury line 4358 ($^3P_1 \rightarrow {}^3S_1$) is heavily absorbed while the line 4078 ($^3P_1 \rightarrow {}^1S_0$) shows no signs of being absorbed under the most favourable conditions Again, lines of the principal series of triplets are not perceptibly absorbed, for the corresponding transitions are $^3S_1 \rightarrow {}^3P_{012}$ but those of the diffuse and sharp series are heavily absorbed, for the corresponding transitions are $^3P_{012} \rightarrow {}^3S_1$ and $^3P_{012} \rightarrow {}^3D$ respectively. Considering the singlets we find that lines of the principal and diffuse series are absorbed, the corresponding transitions being $^1S_0 \rightarrow {}^1P_1$ and $^1P_1 \rightarrow {}^1D_2$ respectively; but those of the sharp series to which belong the mercury line 4916 and the cadmium lines 5155 and 4307 are not absorbed, for the transition in this case is $^1P_1 \rightarrow {}^1S_0$. McCurdy's results for the absorption of the arc lines of helium conform to the above rule. For both singlets and doublets the order of the lowest terms is S, P, D and the lines of the principal (S→P) and diffuse (P→D) series are absorbed whereas those of the sharp series (P→S) exhibit little absorption. Lines of the principal series undergo much heavier absorption than those of the diffuse series on account of the accumulation of the absorbing centres in the metastable states $^1S_0$ and $^2S_1$.

Neon offers an interesting example of the above rule. Let us consider all lines with initial levels 2^1P_1 or 2^3P_1 in absorption and take A/E as a measure of the absorption of a line for purposes of comparison. In the following table A/E is calculated from Meissner's values. Its value for a line has a significance only relative to that for another line. The intensity estimates of the lines are not 'authoritative' (Meissner) but greater accuracy is not necessary for the present purpose.[1]

Initial level in absorption.		Notation.	Int.	% abs.	A/E.
2^1P_1	5852	$2^1P_1-2^1S_0$	80	4	0·05
	6598	$2^1P_1-2^3\overline{P}_1$	12	5	0·41
	6678	$2^1P_1-2^3\overline{P}_2$	25	5	0·20
	6717	$2^1P_1-2^1\overline{P}_1$	14	3	0·21
	6929	$2^1P_1-2^3D_2$	30	3	0·10
	7173	$2^1P_1-2^1D_2$	5	7	1·40
2^3P_1	5400	$2^3P_1-2^1S_0$	40	0	0
	6029	$2^3P_1-2^3\overline{P}_1$	8	5	0·62
	6074	$2^3P_1-2^3\overline{P}_0$	20	7	0·35
	6096	$2^3P_1-2^3\overline{P}_2$	25	6	0·24
	6304	$2^3P_1-2^3D_2$	8	3	0·37
	6382	$2^3P_1-2^3D_1$	30	4	0·13
	6506	$2^3P_1-2^1D_2$	40	8	0·20
	7245	$2^3P_1-2^3S_1$	15	8	0·53

We find that the least absorbed lines are (*i*) 5852 for which the transition in absorption is $^1P_1 \rightarrow {}^1S_0$ and (*ii*) 5400 for which the transition is $^3P_1 \rightarrow {}^1S_0$. The ground-level of neon being $^1S_0$, transitions, $^1S_0 \rightarrow {}^3P_1$ and $^1S_0 \rightarrow {}^1P_1$ in absorption correspond respectively to the first and second resonance lines 743·5 and 735·7; for 5852 and 5400 the transitions are reversed with respect to the sequence symbols and in accordance with the rule the absorption is very small in one case and imperceptible in the other (fig. 3). For other lines listed in the above table which are all perceptibly absorbed the sequence symbols corresponding to the final level in absorption do not occur below 2^1P_1 or 2^3P_1.

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[1] I have not included in the above list the lines 6652, 7024, and 6128 for which no absorption has been observed, for the intensity of each of those lines is only 5 on a scale of 1 to 100 and an absorption of the order of 1 per cent. which would make A/E 0·20 would escape detection.

SELECTIVE ABSORPTION AND METASTABLE STATES.

Of the three initial states in absorption 2^3P_{012} two, namely, 2^3P_0 and 2^3P_2 are metastable, transitions from them to the ground-level, 1^1S_0 being ruled out by the selection principle. It might at first appear that, in all cases, the metastability of a state would tend to the increased concentration of the corresponding atoms relative to atoms in a state such as 2^3P_1 which is not metastable. If it be assumed that the atomic coefficient of absorption is appreciably the same in the three cases, the relative increase of atoms in the states 2^3P_0 and 2^3P_2 should manifest itself in an increased absorption of the lines $2^3P_0 - 2^3S_1$ and $2^3P_2 - 2^3S_1$ in comparison with that of the line $2^3P_1 - 2^3S_1$; but in experience we find the lines $2^3P_{012} - 2^3S_1$ (5461,4358, and 4047 of HgI and 5086, 4800, and 4678 of CdI) are all absorbed nearly to the same extent by the luminous vapour. The life of an excited state is not often the only, nor the main, factor which determines the concentrations of atoms in that state in electrically excited gases and vapours at pressures of the order of a couple of millimetres. Inelastic collisions both of the first and second class play a more important part. The tendency of these collisions is to equalize the concentrations of atoms in

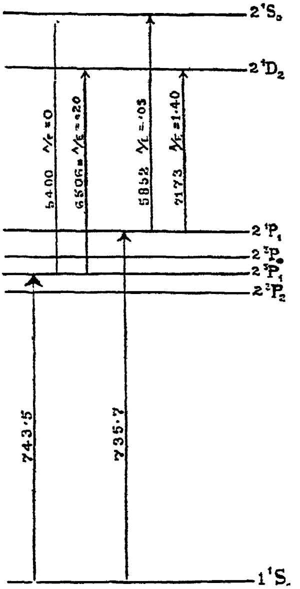
2^1S_0
2^1D_2
5400 $\lambda/\epsilon = 0$
6506 $\lambda/\epsilon = \cdot20$
5852 $\lambda/\epsilon = \cdot05$
7173 $\lambda/\epsilon = 1\cdot40$
2^1P_1
2^3P_0
2^3P_1
2^3P_2
743·5
735·7
1^1S_0

FIG. 3.

Some transitions in absorption illustrating law in the case of neon.

excited states not differing much in energy content. For instance, consider the three states 2^3P_{012} of the neutral Cd. atom.

CdI.

	Term value.	Diff.
2^3P_2	40711	
		1171
2^3P_1	41882	
		542
2^3P_0	42424	

An atom in the state 2^3P_0 may be raised to the state 2^3P_1 as a result of an inelastic collision with a normal atom, the required energy being supplied by the relative kinetic energy of the colliding centres, the smaller the difference in the term values (here, 542) the greater is the number of atoms with relative kinetic energies greater than that required to raise the atom to the higher level. The wave-number corresponding to a quantum equal to the mean kinetic energy of the gas at the absolute temperature θ may be written in the form,

$$\nu=\frac{3}{2}\frac{R\theta}{Nhc}=1{\cdot}048\ \theta$$

where R is the gas constant, θ the absolute temperature, N the Avogadro number, h Planck's constant, and c the velocity of light.

Representing the wave-number difference corresponding to the transition from a state of excitation a to a state of higher excitation β by $\nu_{a\beta}$ we have,

$$\frac{\text{Energy required to produce the transition}}{\text{Mean kinetic energy}}=\frac{\nu_{a\beta}}{\nu}=r\ \text{(say)}.$$

Again representing by n_r the number of molecules in unit volume whose kinetic energies lie beyond r times the mean kinetic energy and by n, the total number of molecules per unit volume, we have

$$\frac{n_r}{n}=1+\sqrt{\frac{6r}{\pi}}\,e^{-\frac{3r}{2}}-\frac{2}{\sqrt{\pi}}\int_0^{\sqrt{\frac{3r}{2}}}e^{-x^2}dx.$$

For the transition $2^3P_0\rightarrow 2^3P_1$ in the case of cadmium $\nu_{a\beta}=542$ and taking the temperature of the luminous Cd vapour as 400° absolute we find for $\frac{n_r}{n}$, 0.27 (*i.e.*,) 27% of the atoms possess kinetic energies due to thermal agitation greater than $hc\nu_{a\beta}$. As $\nu_{a\beta}$ increases $\frac{n_r}{n}$ diminishes rapidly. When it is, say, 3000,

$\frac{n_r}{n}$ becomes negligible. As the result of the large number of possible collisions with normal atoms possessing sufficient relative kinetic energy Cd atoms in the state 2^3P_0 are frequently raised to the higher level 2^3P_1. The reverse process whereby an atom in the state, 2^3P_1 falls to the level 1^3P_0 as the result of a second class impact with a normal atom is to be expected. Such impacts in the case of metastable states check the growth in their number.

The complete transfer of the energy of an excited atom to a normal atom of the same kind as the result of a collision is equivalent to an increase in the mean life of the excited state. An impact of an excited atom of cadmium, for instance, with a normal atom of the same element must be distinguished from an impact of the same excited atom with an atom of a foreign gas, say, an atom of helium whose resonance potential is more than twice the ionisation potential of Cd; in the latter case the radiationless transfer could only result in the transformation of excitation energy to the energy of translation of the colliding centres, whereas in the former there may be a complete transfer of excitation energy from one atom to the other; the latter process lengthens the time during which a quantum remains associated with the atoms of the luminous gas before being radiated. For instance, the concentration of the atoms in the 2^3P_1 state may increase with increase of vapour density though the radiation of the line 1^1S_0—2^3P_1 may not show a corresponding increase. On the whole, inelastic impacts tend to equalise the concentrations of atoms in excited states with close values for the corresponding terms, irrespective of whether one of these states is metastable or not. It has also to be noted that the resonance radiation emitted by an atom in the body of the gas in passing out may be absorbed by a normal atom in its path, thus checking the loss of atoms in the state 2^3P_1 by radiation.

According to Meissner, in electrically excited neon carrying a current of the order of one milliampere per sq. cm. there is a large concentration of atoms in the metastable states 2^3P_0 and 2^3P_2 (Paschen's s_3 and s_5) as shown by the heavy selective absorption of lines with these as initial states in absorption. On the other hand, lines with 2^3P_1 as the initial state undergo comparatively small absorption. This behaviour of excited neon is different from that of Hg or Cd where all the three groups of lines behave similarly in respect of selective absorption. This is all the more remarkable as the three levels 2^3P_{012}, in the case of neon, are much closer together than in the case of either HgI or CdI. In this respect helium behaves like neon, for we find that lines of both the doublet and singlet principal series are heavily absorbed by electrically excited helium, an indication of the large accumulation of atoms in the metastable states 2^2S_1 and 2^1S_0.

SELECTIVE ABSORPTION OF SATELLITES.

As preliminary to the consideration of the selective absorption of the fine structure components of a line it is necessary to decide on a criterion for the comparison of the components in respect of their emission and absorption by the luminous vapour radiating the complex line. The satellites of a heavily absorbed line like the green line of mercury are naturally less absorbed than the strong main component, but if the ratio of emission to absorption for each of these components is the same or nearly the same as for the main line they are classed together as absorbed components. In the axial radiation of a sufficiently long column of uniformly excited gas two neighbouring lines will be of the same brightness if E/A is the same for the two lines; on the other hand, a line that suffers little or no absorption will be brighter than the main component itself. Dr. Metcalfe and myself[1] examined the selective absorption of the satellites of a considerable number of lines in the arc spectrum of mercury. Recently, I have studied this phenomenon in the case of cadmium with the apparatus already described (fig. 1). We may say, in general, that in respect of selective absorption the satellites resemble the main component, being absorbed or not according as the main component is absorbed or not. For purposes of illustration we may first consider the well-known bright green line of mercury. This is a group of twelve lines, the five central lines are very close together and generally unresolved. In the crossed Lummer and Gehrcke plate pattern. the line appears usually as a group of seven components of very unequal intensity. In the axial radiation from a column of 50 cm. of faintly luminous vapour the satellites are all nearly of the same brightness except one, *viz.*,—0·243 which stands out as the brightest of the group. With the lines 4358 and 4047 the same result is obtained, the satellites all becoming nearly equal in intensity when a long column is used as the source except one satellite in the case of 4047, *viz.*, —·013, which like —0·243 of 5461 is unabsorbed and stands out as the brightest of the 4047 group. The relative brightness of the satellites which belong to an unabsorbed line remains the same whether the axial or the transverse radiation is examined. A striking instance is afforded by the line 4078 (2^3P_1—2^1S_0). It consists of a group of six lines of very unequal intensity. In the radiation from a length of 150 cms. of mercury vapour carrying an arc discharge the satellites remain sharp and unaffected in relative brightness; whereas under the same circumstances the satellites of the highly absorbed neighbouring line 4047 equalise in brightness and become fuzzy so that it becomes difficult to distinguish the main line from the other components (see Plate 2, Fig. 1).

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[1] Metcalfe and Venkatesachar, *Roy. Soc. Proc.*, A, Vol. 105, pp. 520–531 (1924).

* * With the discharge tube of the branched arc type already described I have recently examined the selective absorption of the satellites of the prominent cadmium lines. A glass Lummer and Gehrcke plate was used to resolve the lines; and the change in the intensities of the components of a complex line radiated by the strong arc discharge in AB (fig. 1) on starting the branched arc BC by sending a relatively feeble current through the latter, was observed. The satellites of the bright lines 4678, 4800, and 5086 are all markedly reduced in brightness on exciting the absorbing column BC. Of the two satellites of 5086, *viz.*, $-0{\cdot}025$ (*a*) and $+0{\cdot}076$ (*b*) the latter is more absorbed than the former. In the transverse radiation from a luminous column excited feebly, satellite (*b*) is stronger than the satellite (*a*) so much so that some observers, for instance Luneland, do not record (*a*) at all. In the axial radiation (length of luminous column 30 cm.) (*a*) is far stronger than (*b*) and in one of my plates (*b*) is not seen whereas (*a*) stands comparison with the main component. The important cadmium red line 6438 is single and exhibits much stronger selective absorption than the corresponding mercury line 5790. This difference of behaviour between the two lines is due to the fact that the main component of the mercury line which is absorbed is accompanied unlike the cadmium line by 8 satellites which are not perceptibly absorbed.[1]

SELECTIVE ABSORPTION AND THE LINE WIDTH OF SATELLITES.

The thermal agitation of the luminous centres is the main factor influencing the width of a spectral line when the source is a thin layer of the gas under feeble electrical excitation. The stark effect widening due to the electric field of neighbouring ions and atoms becomes important only at high pressures and large current densities. In a line the distribution of intensity due to thermal agitation is given by:—

$$I=I_0e^{-kx^2} \quad .. \quad .. \quad (a)$$

Where I is the intensity at wavelength distance x from the centre of the line and $k=\frac{M}{2R\theta}\cdot\frac{c^2}{\lambda^2}$ (M=mol. wt.). Hence the half-width, w which is defined as the wavelength separation between the centre of the line and a point on either side where the intensity falls to one half that at the centre, is given by

$$w=\sqrt{\frac{\log 2}{k}} \quad .. \quad .. \quad (b)$$

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[1] Metcalfe and Venkatesachar, *Roy. Soc. Proc.*, A, Vol. 105, pp. 520–531 (1924).

This intensity distribution is greatly modified in the case of a heavily absorbed line radiated axially by a long luminous column. It can be shown that the ratio of emission to absorption by a thin luminous layer remains constant throughout a line whose intensity distribution is represented by (*a*). We may write for any point in a line.

$$\frac{\mathrm{E}}{\mathrm{A}} \propto \frac{C_{r\rightarrow a}\,\mathrm{N}}{C_{a\rightarrow r}\,\mathrm{N}_a}$$

where N_r and N_a are the concentrations of the atoms in the states E_r and E_a corresponding to the emission $\mathrm{E}_r - \mathrm{E}_a = hcv$. While N_r and N_a depend also on the mode of excitation, $C_{r\rightarrow a}$ and $C_{a\rightarrow r}$ depend only on E_r and E_a. The intensity distribution in a line for the case of a uniformly excited long column may be shown to be given by

$$\mathrm{I} = \mathrm{I}_0\,\frac{1 - e^{-\mathrm{A}_0 l e^{-kx^2}}}{1 - e^{-\mathrm{A}_0 l}}$$

where l is the length of the column and A_0 the absorption coefficient for the centre of the line.[1] The following table gives values of I/I_0 for corresponding value of x. l is taken to be one metre and $\mathrm{A}_0 = 0{\cdot}4$. In the case of the bright green line of mercury A_0 may be made to exceed ·4 under laboratory conditions of excitation.

I/I_0	x
.99	.00488
.90	.00560
.80	.00595
.70	.00621
.50	.00668
.30	.00721
.20	.00756
.10	.00808
.05	.00855

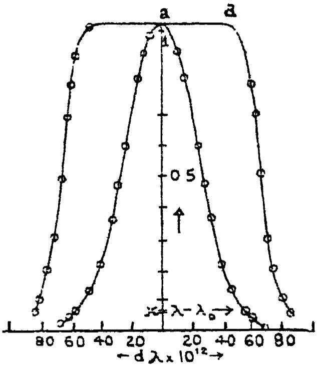

FIG. 4.

Fig. 4 is a graphical representation of the above table. The inside curve represents the intensity distribution when the radiation is from a thin layer. The marked flattening of the first curve in the region corresponding to the middle of the line shows that strong selective absorption greatly diminishes the resolvability of two neighbouring lines so that two close heavily absorbed satellites of a complex line appearing separate when the transverse radiation is examined in a spectroscope of the requisite resolving power may fuse together with no line of demarcation when the radiation is axial This widening of lines due to the depth of the luminous source has been often considered to be unimportant. The late Lord Rayleigh[1] in a paper where he discusses the several causes of the widening of spectral lines says with reference to this cause " it must certainly operate and yet it does not appear to be important in practice ". He bases this remark on the results of certain experiments made by him with sodium flames placed one behind the other. He found that the width of the D lines emitted by a sodium flame was not affected by placing another sodium flame behind it. When the source is a long column of the luminous vapour viewed axially, a comparative study of the fine structure components of lines heavily absorbed and of those not heavily absorbed reveals a striking difference in appearance. The heavily absorbed components distinctly widen out in the axial radiation and equalise in brightness with the lines of demarcation between them often wiped out; whereas a group of satellites suffering no perceptible absorption remain bright and sharp with their relative intensities hardly affected.[2]

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[1] Venkatesachar, *Phil. Mag.*, 49, p. 33 (1925).

SELF-REVERSAL AND FINE STRUCTURE.

The fine structure pattern of a spectral line as revealed by an instrument of high resolving power is often profoundly modified as the result of self-reversal of one or more of its components caused by the relatively greater absorption of the central part of the widened satellite in its passage through vapour under feebler excitation. It is not often realized that strong electrical excitation or high density of the luminous vapour is not essential for the production of self-reversal. If the line is heavily absorbed thermal agitation and the depth of the radiating vapour are frequently enough to produce the requisite widening. In the course of experiments on the selective absorption by electrically excited cadmium vapour mentioned earlier, a reversal of this kind was observed in the case of the main component of the line 4800 Å (2^3P_1—2^3S_1) when the pressure of the vapour in the luminous vapour in the radiating and absorbing columns could not have been more than a millimetre of Hg. It was found that, on gradually increasing the current in the absorbing column a relatively dark dividing line was seen in the middle of the main component which subsequently disappeared, the intensity of the line as a whole continuously diminishing. Such a phenomenon was not observed in the case of the line, 5086 (2^3P_2—2^3S_1). Apparently the widening due to the depth of the radiating column was not enough in this case, showing that the selective absorption of the main component of 5086 is less than that of the main component of 4800. If in the analysis of a heavily absorbed line special care is not taken to prevent self-reversal, an incorrect representation of its fine structures will result. As an example the resonance line of mercury may be mentioned. Examining the line by two Lummer and Gehrcke plates of quartz, Nagaoka[1] and his collaborators, came to the conclusion that it is a group of 25 components of varying intensity. On the basis of an elaborate and careful analysis of this and other lines in the arc spectrum of mercury the Tokyo Physicists assuming that a proton is detached from the nucleus of the mercury atom and is quasi-elastically connected with it, traced the complex fine structure of the lines to the six isotopes of mercury. R. W. Wood[2] in a set of elegant experiments has conclusively shown that the analysis of 2536 by Nagaoka and his collaborators is vitiated by the self-reversal of the components. According to him it is made up of five components of nearly the same intensity. The analysis of other heavily absorbed lines has to be revised before any comprehensive theoretical explanation of the complex fine structure of the arc lines of mercury can be attempted. The self-reversal of the components combined with their widening and equalization of intensity renders difficult the interpretation of the fine structure patterns of heavily absorbed lines when emitted by long columns (Plate 2, Fig. 2). While it is therefore necessary to avoid to the use of a long column as source in the analysis of such lines, its use offers a decided advantage in the analysis of weak lines or of lines that are not perceptibly or even markedly absorbed. The unabsorbed mercury line 4916 is a good illustration in point. This line has always been described as single. Janicki,[3] who has made a careful study of the fine structure of mercury lines, says regarding this line:—'Neither the Lummer lamp nor the quartz lamp allowed the recognition of satellites in spite of more than one hour's exposure and several experiments with all the three kinds of plates'. But in the radiation from a column 30 cms. in length of arc discharge in low density mercury vapour carrying a current of 2 amps. per sq. cm., it is found to be a group of 6 lines[4] (or more likely 7) as revealed by two quartz Lummer

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[1] Rayleigh, *Phil. Mag.*, 29, pp. 274–284 (1915).

[2] *Loc. cit.*

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[1] *Japanese Journal of Physics,* Vol. 2, p. 121 (1923).

[2] *Phil. Mag.,* Vol. L, p. 761 (1925).

[3] Janicki, *Ann. d. Physik,* 29, p. 833 (1909).

[4] G. Hansen says that he finds this line to be a group of at least five lines. The two satellites mentioned above of the existence of which there is no doubt, do not find a place in his list. His apparatus probably did not resolve them from the main line. One of these, *viz.,* +0·030, is

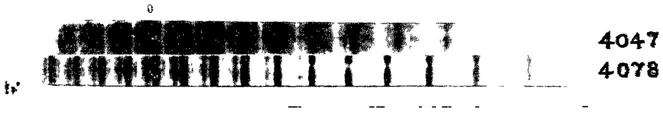

FIG. 1.

Relative satellite intensity in long column radiation.

Note the widening and equalization in intensity of the satellites of the heavily absorbed line 4047 of Hg, and the sharpness and unaltered relative intensity of the components of the unabsorbed line 4078.

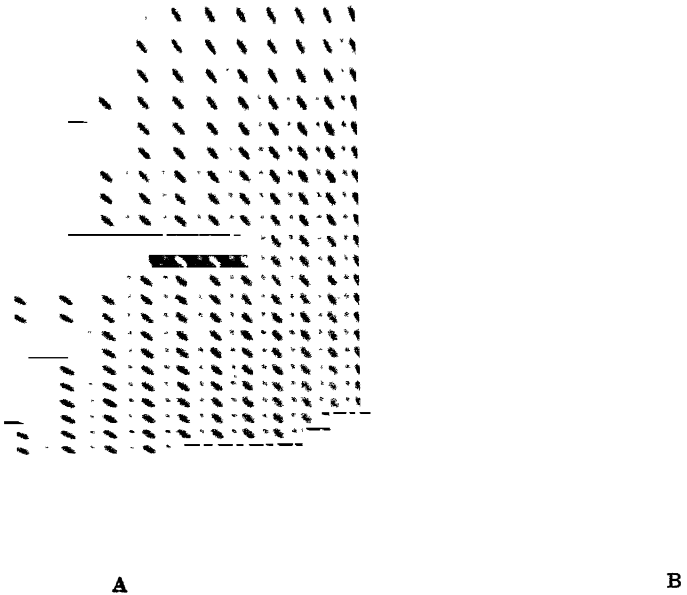

FIG. 2.

Crossed Lummer plate pattern of Hg 5461 Å.

(A) Source :—thin low density layer. Shows satellites with correct relative intensities. The thick elongated dot is a group of five unresolved lines.

(B) Source :—a long column. The pattern is complicated by self-reversal. The prominent bright dot is the unabsorbed satellite—0·237.

and Gehrcke plates of different thicknesses used separately and also crossed.** The main component is flanked on either side by two satellites (Plate 3, Fig. 1).

	Int.
+0·030	3
0	10
—0·018	1·5

The wavelengths of the other satellites I have not yet fixed, as being faint they did not come up distinctly in the crossed plate pattern, for want of sufficient exposure. The satellite +0·030 when unresolved from the main component producing the appearance of a hazy wing towards the red has, no doubt, resulted in the line being described in tables as being diffused towards the red. In other cases, though not in all, the presence of close unresolved satellites may be the origin of diffuse appearance towards red or violet. 4916 is a line that is not perceptibly absorbed. But even in the case of a line that is perceptibly but not heavily absorbed a long column does not produce as the result of self-reversal any complication that would distort its real composition except in so far as the relative intensities are altered. In order to test this point I determined the wavelengths of the satellites of the mercury line 5769 which suffers distinct but not heavy selective absorption, using the axial radiation from a mercury vapour lamp 30 cm. in length with a water-cooled cathode carrying a current of 2 amps. per sq. cm. The following table gives the wavelengths of the satellites along with those found for them by Janicki[1]:—

5769 (Hg)

Author	Janicki
+0·046	+0·044
−0·052	−0·052
−0·113	−0·114

DOPPLER EFFECT AND FINE STRUCTURE.

Doppler effect sometimes may effect slightly the measured wavelengths of satellites when the source is an electrically excited long column. Small changes in wavelength indicating a drift of the luminous centres towards the cathode, have been observed. In certain experiments carried out by Dr. Metcalfe

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the brightest of the satellites. The wavelengths of other satellites given by Hansen do not in every case agree with my values. It is not known what kind of source and resolving system he used. The matter is under further investigation.

[1] *Loc. cit.*

and the author, the shift in the position of the main component produced by reversing the direction of the current in the line of observation indicated a velocity for the luminous centres of 300 metres per sec. towards the cathode. Perot has made a series of experiments on this effect and finds for the radiators of the mercury green line, velocities ranging from 400 metres to 30 metres per sec., the velocity diminishing with increase of pressure in the luminous vapour. If all the components of a line suffered the same Doppler effect displacement, as only differences of wavelength are important, no error is introduced in the measurement of these differences. Even when the displacements are different for different satellites the discrepancy introduced by the Doppler effect is easily corrected by taking in the case of each satellite the mean of two observations, one with the positive ions moving towards the observing system and the other away from it, made with reference to the main component or to some fixed satellite. In passing, it may be mentioned that Doppler effect is no indication of the radiators being positively charged; the velocity towards the cathode may be acquired by the singly charged positive ion before capturing the optical electron.

THEORY OF FINE STRUCTURE.

In considering the theory of fine structure, I shall omit relativity fine structure and the fine structure of the series lines of light atoms such as the doublet structure of Lithium lines. These are fairly well understood. Attempts have been made to explain the existence of satellites by attributing them to the isotopes of elements. Nagaoka, Suguira, and Mishima[1] have tried to trace the components of mercury lines to the six isotopes of mercury with atomic weights 197, 198, 199, 200, 202, and 204 on the hypothesis already referred to (*viz.*,), that a proton is detached from the nucleus of the mercury atom and is quasi-elastically connected with it. The agreement between the observed wave-number differences of the satellites and those calculated by the above authors on the basis of their theory loses significance in view of the fact that, according to the more recent work of Aston[2], the isotope with atomic weight 197 does not exist but instead there is one of atomic weight 201. McLennan, Ainslie, and Miss Cale[3] put forward the view that the three central components of the mercury green line (5461) may be corresponding lines of the isotopes, 202, 200, and 198. They based their conclusion on the fact that the wave-number differences of corresponding satellites multiplied by the atomic number coincided with those calculated on the Bohr theory and that, according to them, of the twelve components of this line these three are the only ones that exhibited marked selective absorption. It may be stated that the ratio of emission to absorption must be the same for corresponding lines of isotopes and as we find that 11 of the 12 components of the green line are nearly of the same intensity in a long column, a test of the approximate equality of E A for them, the three satellites considered by McLennan and his collaborators cannot be separated from the others and attributed to mercury isotopes on the strength of selective absorption.[1]

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[1] *Loc. cit.*

[2] *Roy. Soc. Proc.*, Vol. 115A, p. 508 (1927).

[3] McLennan and others, *Roy. Soc. Proc.*, A, Vol. 102, p. 33 (1922).

The wavelength of the line 4058 in the spectrum of ordinary lead differs from its wavelength in the spectrum of lead from a radio-active source by an amount of the order of 0·0043Å. A few other lines examined by Merton[2] also show a difference of wavelength depending on the source of the lead used, the difference being different for different lines. Though this is undoubtedly an isotopic effect, the observed difference is about a hundred times the calculated value. Another instance in which fine structure has been attributed to isotopes is furnished by neon. According to Hansen[3] each of the neon lines with an s-term (Paschen) as the first term has a satellite on the shorter wavelength side with an intensity ranging from $\frac{1}{4}$ to $\frac{1}{10}$ of the main line. He thinks that the main line and the satellite are respectively produced by the two isotopes 20 and 22, and adduces as evidence a provisional observation of his on the Zeeman Effect of the components of the lines 5852 and 6266. The satellite showed the same splitting as the main line up to a field strength of 15,000 Gauss, a result which is to be expected if the structure is due to isotopes. If we admit that the change in the wave-number is solely due to a change in the nuclear mass we have,

$$\frac{\delta\nu}{\nu}=\frac{a}{1845A^2}$$

where A is the mean atomic weight of the two isotopes and a, the difference in the weights. In the present instance $\delta\nu/\nu$ is $2{\cdot}46\times10^{-6}$ but the observed value is about $4{\cdot}4\times10^{-6}$. This want of agreement between the calculated and observed values probably cannot be taken as a strong argument against the isotopic origin of the observed doublet structure of neon lines. The determination of the intensity ratio of the components would provide a suitable test of the correctness of the hypothesis. To avoid the effect of self-reversal one has to choose for this purpose lines which undergo little selective absorption.

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[1] *Loc. cit.*

[2] Merton, *Roy. Soc. Proc*, 100A, p. 84 (1921).

[3] G. Hansen, *Naturwissenschaften*, 15, p. 163 (1927).

The two lines 5400 and 5852 are best suited for this purpose. In the discussion on isotopes, Merton[1] remarks that he and Lindemann could get no conclusive result in an attempt to analyse the lines of neon with the object of discovering an isotopic effect. The failure is attributed to the physical width of the line, about ·0074 at 300° absolute. This remark of Merton impelled me to examine some of the neon lines in a quartz Lummer plate made by Hilger which could easily separate a satellite of wavelength 0·025 from a line whose half-width is 0·0074. In a preliminary analysis of the line 5852 it is found that there is a satellite of wavelength 0·028Å ($\delta\nu/\nu = 4{\cdot}8 \times 10^{-6}$) agreeing within the limits of experimental error with the value given by Hansen. The relative brightness of the satellite from a rough visual estimate, may be said to be near the calculated value 1 : 9. There is also an indication of a satellite on the longer wavelength side of the main line but closer to it than the one mentioned by Hansen. In view of these facts, the case of neon deserves further investigation and the suggestion of Hansen[2] needs confirmation by further work. The red line 6708 of lithium has been the subject of fine structure analysis by a number of investigators with a view to detect the faint companion of each line of the doublet due to the isotope Li_6. Schüler and Waren[3] claim that in the fine structure pattern of this line which they have obtained, the isotope effect is noticeable and that the strong component of Li_6 coincides with the weak component of Li_7. It must, however, be remembered that, according to Schüler[4], that, also in the case of sodium, each of the D lines is a doublet with a wavelength separation of 0·02Å and an intensity ratio of 1 : 2 about, and sodium has no isotopes.

After the advent of Bohr's theory of spectral radiation it was natural to look for an explanation of the fine structure of a complex line in the complexity of the initial and final levels involved in its emission. Nagoaka and Takamine noticed certain constant differences in the wave-numbers of the satellites of complex lines in the spectra of elements like mercury, cadmium, and bismuth. It was, however, Ruark and Chenault[5] who treated all the fine structure data available up to the year 1925 and accounted for the existence of satellites in a number of cases by splitting the initial and final levels of a complex line, each into a group of close sub-levels and assigning to each sub-level a wave-number. These investigators attempted also to assign fine quantum numbers to the sub-levels and showed that in the case of thallium transitions giving rise to the satellites obeyed the selection rule δf (fine quantum number) $= \pm 1$ or 0. The fine structure data of mercury lines has been treated separately by Ruark.[1] Portions of the results obtained by these authors are likely to stand the test of further investigation but a considerable part requires revision, especially is this the case with mercury where the data used are often vitiated by self-reversal. MacNair[2] has attempted to assign fine structure level for some of the arc lines of cadmium and account for their structure. A. Schrammen[3] has made a careful analysis of the cadmium lines and in the manner of MacNair has also given a scheme of fine levels accounting for the observed structure. Often it is possible to suggest alternative schemes for the fine structure levels and there is no criterion to decide which scheme really represents facts. In the case of mercury, some of the satellites of a complex line are strongly absorbed selectively, while others are not so absorbed. This fact may offer a clue in fixing fine structure levels. For instance, of the twelve components of the mercury line 5461, only one, *viz.*,—0·237 is unabsorbed, also of the nine components of 4047, one 0.012 is not absorbed. Starting from the hypothesis that these two unabsorbed satellites are emitted as the result of transition from the same fine structure level of 2^3S_1, I have, in collaboration with Sibaiya, split the 2^3S_1 and 2^3P_{012} levels of HgI in a manner different from that of Ruark and accounted for a large number of satellites of prominent lines.

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[1] Merton, *Proc. Roy. Soc.*, 99A, p. 101 (1921).

[2] Hansen himself says that 'a thorough investigation of this question has been undertaken'. *loc. cit.*

[3] Schüler and Waren, *Naturwissenschaften*, Vol. 16, pp. 512–513 (1928).

[4] Schüler, *Naturwissenschaften*, Vol. 16, pp. 512–513 (1928).

[5] Ruark and Chenault, *Phil. Mag.*, Vol. L., p. 937 (1925).

There now arises the question, 'What brings about the complexity in the levels, initial and final, corresponding to the emission of a line having satellites?' The theory which successfully answers the question in two cases at any rate is that the nucleus of the atom has a quantised rotation with a quantum number i: the quantised vector sum of i and the internal quantum number, j, ranging between $|j+i|$ and $|j-i|$ gives the fine quantum numbers of the sub-levels. Back and Goudsmit[4] have shown that the fine structure of certain bismuth lines can be explained by the hypothesis of a nuclear rotation with an impulse moment of $4\frac{1}{2} \cdot \frac{h}{2\pi}$. They have confirmed their theory by a study of the Zeeman Effect of the fine structure components. It follows from the behaviour of the satellites in a magnetic field that the impulse moment of the nuclear spin is $4\frac{1}{2} \cdot \frac{h}{2\pi}$ as assumed by these investigators. The other case is that of caesium.[1] The lines of the principal series of this element have been shown by Jackson to be close doublets and this structure may be accounted for by assigning to the nuclear spin of the caesium atom an impulse moment of $\frac{1}{2} \cdot \frac{h}{2\pi}$. The result of this is to split the 's' level and each of the 'p' levels into two close levels as shown below :—

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[1] Ruark, *Phil. Mag.*, Vol. 1, p. 977 (1926).
[2] MacNair, *Phil. Mag.*, 2, pp. 613–621 (1926).
[3] A. Schrammen, *Ann d Physic*, 83, pp. 1161–1199 (1927).
[4] *Loc. cit.*

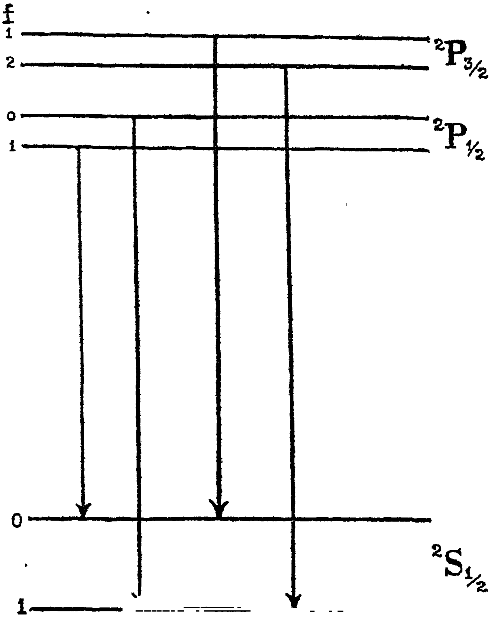

FIG. 5.

Recently Hargreaves,[2] starting from the hypothesis of a nuclear spin and applying the methods of the new mechanics, has derived for caesium fine structure energy levels and a selection rule, *viz.*, that, during a transition, the quantum number, *f*, can change only by $\pm$ 1 or 0. While there is so far agreement between theory and experiment the intensity relations calculated from theory are not in conformity with the experimental results of Jackson.

The explanation of the existence of satellites on the basis of nuclear rotation requires that all the lines of a series should possess the same type of fine structure. This is so with the first three doublets of the principal series of caesium. The available experimental data is not enough to apply the test in other cases; for generally it is the first line and sometimes the second line of a series whose fine structure has been investigated and correctly known. The chief difficulty in the way of the experimental investigation of the fine structure of the higher members of series lines is the rapid fall in their intensity as the current term number increases. There appears, however, to be no doubt that the similarity in the patterns of lines of the same series which a nuclear rotation requires is not apparent in the mercury lines. It is unlikely that all the satellites in the complex fine structure of the mercury lines could be accounted for on any single hypothesis such as a quantised nuclear rotation.

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[1] *Loc. cit.*

[2] *Roy. Soc. Proc.*, A, Vol. 124, p. 568 (1929).

Another possible origin of fine structure has been suggested by Ruark and Chenault.[1] They think that small quantised variations of the configuration of the outer shells can cause alterations of the energy levels of the light-electron. Apart from the somewhat indefinite nature of the suggestion there is the objection to it that, once the energy levels corresponding to an electronic configuration are uniquely determined by the methods evolved by Pauli, Heissenberg, and Hund, we have to look for fine structure levels in an agency outside the electronic system and not in the electronic system itself, as for instance, a nuclear rotation. Recently Schüler and Brück[2] have put forward an interesting and suggestive explanation of the structure of some of the cadmium lines, especially of the triplet $2^3P_{012}—2^3S_1$. The main component of each of the lines considered is attributed to Cd atoms with zero nuclear impulse moment and the satellites to Cd atoms with a nuclear impulse moment, $\frac{1}{2}$. The atoms with zero nuclear moment belong to the isotopes with atomic weights 110, 112, 114, and 116, while those with nuclear moment $\frac{1}{2}$ are of the isotopes 111 and 113. The lines $2^3P_{012}—2^3S_1$, *viz.*, 4678, 4800, and 5086 ought according to the theory possess 2, 4 and 3 components respectively excluding the main line; but the observed structures show only 2, 4 and 2 components.[3] The explanation that the $^3P_2$ level may not be split is unconvincing. These investigators, further, state that the observed intensities in the fine structure patterns agree with Aston's estimation of the relative abundance of the isotopes in cadmium.

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[1] *Loc. cit.*

[2] Schüler and Brück, *Z. Physik*, 56, p. 291 (1929).

[3] Schüler and Brück state that the fine structure components of 5086 should be 5. This number results from their representing the fine structure levels of $^3P_2$ to be three in number whereas they are really two with f values $2\frac{1}{2}$ and $1\frac{1}{2}$ giving only three fine structure components for 5086 excluding the main component which, according to the theory, does not belong to this group.

The above brief sketch of the theoretical side of this subject shows how incomplete at present is our understanding of the origin of fine structure. The available experimental data are often inadequate for a comprehensive theoretical treatment. The required data may be classified under the following four heads:—

(*i*) The accurate determination of the wavelengths of the satellites of as many as five or six lines in a series.
(*ii*) Relative intensities of satellites.
(*iii*) The influence on the satellites of the mode of excitation
(*iv*) Their Zeeman Effect.

We shall consider (*i*) last.

(*ii*) Generally rough estimates of the intensities are alone given by investigators. The estimates of one investigator often widely differing from those of another. As already noticed, the relative intensities are unaffected by the thickness of the radiating layer for the components of lines which exhibit feeble selective absorption; but with heavily absorbed lines a luminous layer of not more than 1 cm. is enough to distort the relative brightness of the components. It is hardly necessary to emphasise the importance of a study of relative intensities of satellites, for any satisfactory theory has to lay down rules for computing relative intensities and the observed data provide us with a check on the theory.

(*iii*) A change in the mode of excitation, it is well known, often profoundly affects fine structure. An interesting case which has been studied by Collins[1] may be mentioned. The mercury green line 5461 Å is a group of twelve components, the five central ones appearing ordinarily as an unresolved line. The structure of the line in the radiation from mercury vapour optically excited by two mercury vapour lamps, was examined, 1st, when the vapour was pure, and 2nd. when it was mixed with nitrogen at a pressure of 2 mm. of Hg. In the first case, only the central component appeared, while in the latter case, in addition to the central component one other satellite with wavelength—0·237 showed up. That none of the satellites of this complex line should be radiated when pure mercury vapour is optically excited appears to me to be a very interesting result. It is of interest to note that, while 11 of the 12 components of 5461 suffer marked selective absorption, the single satellite radiated along with the main component in the second case, *i.e.*, in the presence of nitrogen, is the one which has been shown by Dr. Metcalfe and the present writer[1] to suffer hardly any absorption.

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[1] Collins, *Phys. Rev.*, Vol. 32, p. 753 (1928).

(*iv*) *Zeeman Effect.*

The study of the Zeeman Effect has been a powerful aid in the interpretation of multiplet structure. It is natural to expect that a similar study in the case of the satellites of complex lines would give us a clue to the origin of fine structure. This expectation has been realized in the case of bismuth, for, as already mentioned, Back and Goudsmit[2] have confirmed their hypothesis that the nucleus of the bismuth atom has a rotational impulse moment of $4{\cdot}5 \times \frac{h}{2\pi}$ by a study of the Zeeman effect of the satellites. Pauli,[3] who was the first to suggest a nuclear impulse moment as the cause of fine structure, adduced in support of his hypothesis the work of Nagaoka and Takamine[4,5] who found that the Zeeman effect of the satellites of the mercury triplet 2^3P_{012}—2^3S_1 in strong magnetic fields showed a resemblance to the Paschen-Back effect. But more recently MacNair[6] finds that the behaviour of the components of the mercury resonance line 2536 in a magnetic field does not indicate the presence of this effect. It may be said that at the present moment there is no theory that even qualitatively accounts for the fine structure of the mercury lines. Wali Mohammad,[7,8] in addition to investigating the fine structure of the prominent line of a number of elements, has studied the Zeeman effect of the satellites of the CdI triplet 2^3P_{012}—2^3S_1; and obtained interesting results some of which Ruark has attempted to interpret. The importance of the Zeeman effect data for an understanding of the origin of fine structure cannot be over-estimated. But the interpretation of Zeeman patterns of complex lines even in magnetic fields of the order of 5,000 gauss is a problem of no small difficulty on account of the nearness of the satellites to one another.

(*i*) *Analysis of lines of the same series.*

As the intensities of the higher members fall off rapidly as we move up the series, every device of intensifying these lines without widening them and producing self-reversal must be sought for. What appears to me to be an important consideration here is the density of the luminous vapour. Within a range of pressure of 2 mm. to 0·1 mm. the effect of diminishing the density of the luminous vapour is to increase not simply relatively but absolutely the intensities of series lines below $m=5$ and diminishing the intensities of all lines above $m=6$[1] (Plate 3, Fig. 2). I have tested the correctness of this statement in the case of mercury, cadmium, and zinc and believe it holds also in other cases. To quote an instance in a mercury vapour lamp, the line 4916 (2^1P_1—3^1S_0) has its brightness enhanced by 40 per cent. on lowering the pressure from 2 mm. to 0·1 mm. This increase in intensity is due to the diminution in the loss of the radiating centres of the lower members by radiationless transitions caused by collisions with normal atoms. The contrary behaviour of the higher members results from the fact that their radiating centres unlike those of the lower members are produced by inelastic impacts of thermally energetic normal atoms and the radiators of the lower members. The relative kinetic energy of the impinging atoms is often sufficient to produce the transition corresponding to a change of m from 7 to 8 but rarely so for a transition from $m=3$ to $m=4$. In addition to increasing the brightness of the earlier members of a series by reducing the pressure of the luminous vapour to 0·1 mm., we secure sharpness in the fine structure patterns and avoid also the confusion arising from neighbouring faint lines such as the higher members of lines of other series which disappear at such pressures. Using a long column of steady arc discharge at pressures of the order of 0·2 mm., I have been able to obtain the fine structure of such faint lines as 5026 (2^1P_1—3^3S_1) of Hg. The same method has revealed the satellites of 6907, 6716, 6234, 6123, 6072, and other lines, which, so far as I am aware, have not been analysed for want of sufficient illumination.[2]

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[1] *Loc. cit.*

[2] *Loc. cit.*

[3] Pauli jr., *Naturwissenschaften*, 12, p. 741 (1924).

[4] *Phil. Mag.* XXVII, p. 333. (1914).

[5] *Phil. Mag.* XXIX, p. 241. (1915).

[6] MacNair, *Phys. Rev.* 31, pp. 986-996 (1928).

[7] Wali Mohammad. *Ann. d. Physik.* XXXIX, p. 225 (1912).

[8] Wali Mohammad, *Astrophysical Journal*, 39, p. 185 (1914).

I have, in this address, attempted to discuss briefly the salient features of fine structure. Greater stress has naturally been laid on the experimental side of the problem; for, as pointed out at the beginning, the amount of experimental work that remains to be done is enormous compared with what has been done already. We may here recall the words of Prof. Sommerfeld. He says: "Before such a fifth quantum number may be introduced, it must be decided whether the combination principle also holds for satellites, that is, whether the satellite-lines are given by the energy difference between an initial and a final state. It will be a beautiful and at the same time a difficult task for the spectroscopists to solve this prob-

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[1] Venkatesachar, *Roy. Soc. Proc.*, A, Vol. 117, p. 11 (1927).

[2] Details will be published elsewhere.

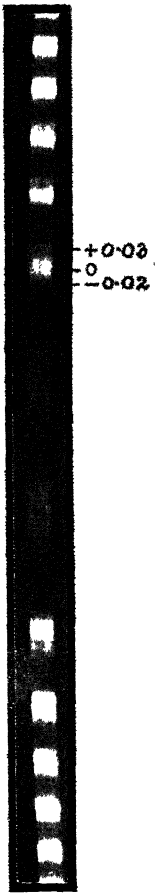


FIG. 1.

Structure of the mercury line 4916.
Single Lummer plate pattern
showing satellites.

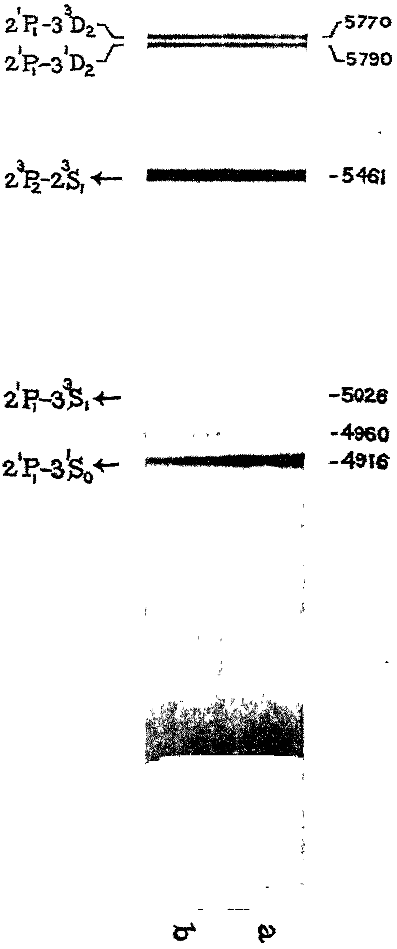


FIG. 2.

Mercury arc spectrum.
(*a*) Pressure—0·1 mm.
(*b*) „ —2·0 mm.

The lines with arrow marks are brighter in (*a*) than in (*b*). The faint lines near 4916 and 5026 present in (*b*) are absent in (*a*).

lem experimentally. Theoretical spectroscopists have to wait until the experimenters have preceded." The subject is one that calls forth all the experimental ingenuity of the most capable investigator and ought to attract the growing band of enthusiastic and capable young workers in our country to a greater extent than it has hitherto done. The theory of fine structure has not yet passed the stage of infancy and here again there is great scope for work. It is not too much to expect that in the solution of some of the outstanding problems of modern physics the information supplied by the study of fine structure will play an important rôle.

Section of Mathematics and Physics.

Abstracts.

1. On the Constitution of the Triatomic Molecules.

P. N. GHOSH *and* P. C. MAHANTI, Calcutta.

The constitution of the symmetrical triatomic molecules of the XY_2 type, such as CO_2, SO_2, NO_2, CS_2, H_2O, N_2O and H_2S have been discussed. The available data on their vibration-rotation spectra do not point conclusively to their structure since in the case of a triatomic molecule, both the linear and the triangular models have three normal modes of vibration. Hence the data on refractivity, dielectric constant, light-scattering and Raman effect of the molecules have been considered to get a definite idea about the structure of each molecule in each case. The d.E.K. of CS_2 and N_2O have also been measured by the heterodyne null method.

2. A review of the method of horizontal comparison in the location of spectra of elements.

K. MAJUMDAR, Allahabad.

An account is given of the method of horizontal comparison in the location of spectra of elements which is being used in this laboratory with success for the past two years.

If we consider the spectra of a group of successive elements, as for example,

$$Al,\ Si,\ P,\ S,\ Cl,\ A \text{ and } K,$$

then the wave-numbers of the strongest lines of the elements due to the transition $N_1 \leftarrow N_2$ increase linearly with the atomic weight. This law has been found to be applicable in other similar groups, say,

$$C+,\ N+,\ O+,\ F+,\ Ne+,\ Na+,\ Mg+.$$

Hence with the help of this method the location of the lines in the spectrum of an element has become simple. In fact this method has been used with success in locating the spectra of a number of elements, which have recently been classified,

e.g., $Na+,\ Ca++,\ S+,\ Cl+,\ Br+,\ Br++,\ Kr++$ etc.

It has been found that the law holds only when the transition takes place between orbits having the same total quantum number,

e.g., $N_1 \leftarrow N_2;\ M_2 \leftarrow M_3$,

as is the case with Millikan and Bowens' Irregular Doublet law.

3. Fine structure of some lines of bismuth in the ultra-violet.

WALI MOHAMMAD, Lucknow.

The method employed for the investigation was the same as has been successfully employed by the author in his previous work on the fine structure of the Spectrum lines. A specially constructed vacuum arc was employed for producing the source of light and Quartz Lummer-Gehrcke plates of different dimensions were used in conjunction with a Hilger Quartz Spectrograph for photographing the resolved lines. Thus the fine structure of several lines has been determined. Their values are given.

4. Structure and Movement of Cyclones in the Indian Seas.

S. C. Roy *and* A. K. Roy, Poona.

Meteorologically, the year in India falls into four natural periods :—

(*a*) The *winter period* (December to March) when north-westerly winds of land origin extend uninterruptedly in the Indian ocean up to the equator.

(*b*) The *pre-monsoon or the hot weather period* (April to June) characterised by a gradual extension of the oceanic air into the Indian Seas and terminated by the establishment of the south-west monsoon.

(*c*) The *monsoon or the rainy period* (July to September) when south-westerly winds of oceanic origin hold full possession of the Indian Seas.

(*d*) The *post-monsoon period* (October to November) when the oceanic air retreats southwards from the Indian Seas and are replaced by north-easterly winds of land origin.

Severe cyclones (*i.e.*, cyclones with winds of force 10 and above and occasional hurricane squalls) are practically unknown in the winter months when north-easterly land winds take full possession of the Indian Seas, and are of extremely rare occurrence during the monsoon period when winds of oceanic origin dominate the whole of the Indian Seas. They are most frequent during the transition periods when air masses of land and oceanic origin are struggling to replace each other.

In the beginning of the pre-monsoon period the cyclones usually form near Lat. 8°N and with the northward extension of the oceanic air their place of origin shifts to the neighbourhood of Lat. 12°N in May and to near Lat. 18°N in June. In the post-monsoon period, the region where cyclones occur retreats from the north of the Indian Seas to the south in the reverse manner from the end of September to the middle of December. It would thus appear from the seasonal distribution of the cyclones and the regional sequence of their origin that the mechanics of the growth of cyclones in the Indian Seas should be sought in the meeting place between the land and oceanic air masses.

The growth of tropical cyclones is preceded by the formation of an 'active upglide surface' in which moist oceanic air overruns the north-westerly land winds or the local south-westerly winds of the pre-monsoon period, and the north-easterly land winds of the post-monsoon period. In the earlier stages of formation of the 'upglide surface,' the over-running of the land air by the oceanic air is only noticeable in the upper air. The ascension of the moist oceanic winds along the 'upglide surface' causes continuous condensation and precipitation of water vapour. The latent heat released as the result of condensation raises the temperature of the ascending moist air at the elevation where condensation is taking place. Rarefaction of the air over the area of excessive condensation and precipitation is thus energetically kept up. Air rushes into the area of convection from all directions and if this area is sufficiently to the north of the equator the deflective force of the earth's rotation comes into operation on the inflowing air resulting in the formation of a cyclonic circulation. The principal seat of energy of the cyclone is located in the region above the 'active upglide surface' and the cyclonic circulation travels towards that region in the general direction of the oceanic winds feeding the cyclone.

During the transition periods two distinct air currents of oceanic origin are recognisable;—one is from the south-west and the other from the south-east. The cyclone travels north-westwards if the south-easterly air gains over the south-westerly monsoon, but it curves to the north-east if the south-westerly monsoon overpowers the south-easterly winds. The usual parabolic tracks followed by the cyclones of the Indian Seas are thus explained.

The paper is illustrated by a series of weather charts showing the structure of cyclones in the Indian Seas. The usual idea of a tropical cyclone is that it is constituted of a revolving air mass. But the evidence put forth in this paper seems to suggest that the motion of a tropical cyclone is analogous to the transmission of a wave.

5. Origin of Nor'westers in Bengal.

G. CHATTERJEE *and* S. C. ROY, Poona.

During the hot weather period, Bengal and Orissa are visited by a class of severe thunderstorms known as "Kal Baishakhi" or the Fateful Thing of the Month of Baishakh. These storms, although of very local character, often cause great loss of life and property.

During the last hot weather one of the authors (Mr. Chatterji) led an expedition to south Bengal to investigate the upper air conditions during the occurrence of Nor'westers. The results so far obtained appear to indicate that Nor'westers are caused by the *overrunning of hot moist southerly or south-westerly winds by a cold north-westerly air of super-adiabatic lapse rate.* This overrunning is conditioned by the disturbances of the season that enter north-west India from Persia and move eastwards across the country towards Bengal.

6. On some experiments with Ultra-short waves.

D. V. GOGATE *and* D. S. KOTHARI, Allahabad.

The experiments described in the first section of this paper are a continuation and extension of the experiments of Mr. B. Mujumdar (Ind. Jour. Phy., 1928). Short waves ranging down to three meters are generated by means of a French valve and are detected on a Lecher-wire system. The relation (given by Gill & Donaldson, Phil. Mag., 1926) between the change in the wavelength of the oscillations generated, and the change in the length of the wires forming the oscillatory circuit is verified. From the observed values of L and λ the value of C_0 the grid-plate capacity is calculated by using the ordinary theoretical formulæ for L and C and taking into account the self capacity of the wires forming the oscillatory circuit.

In the second section the effect of coupling two resonant circuits to the same valve is studied and incidentally this arrangement is made use of in determining the inter-electrode capacity between the grid and the plate of the valve, by applying the theory of capacitative coupling. The values of the grid-plate capacity thus obtained are then compared with those directly calculated from the theoretical formulæ in section 1.

7. A note of Ultra-short waves and Radiation from free electrons.

D. S. KOTHARI *and* D. V. GOGATE, Allahabad.

An attempt is made to repeat Prof. Yagi's Magnetron experiments with a triode valve and a theoretical discussion regarding the origin of his short waves is given. The fact that in Prof. Yagi's experiments the source of radiations is the free electrons describing a closed path (almost circular) between the filament and the anode is clearly brought out.

8. On the evaluation of certain definite integrals involving Ferrer's associated Legendre Functions of the first and second kind.

HRISHIKESH SIRCAR, Dacca.

J. W. Nicholson has investigated in a very elegant way some of the properties of Zonal harmonics of the second kind and Ferrer's associated Legendre Functions of the second kind, in connection with the solution of an integral equation arising in the problem of the determination of the capacity of an electrical condenser composed of two parallel conducting disks. He had to evaluate the integral

$$\int_{-1}^{1} [Q_n(x)]^2 \, dx$$

which is fundamental in nature. It would not be too much to say that his prolific abilities have placed the analyses with regard to the Zonal harmonics of the second kind and Ferrer's associated Functions of the second kind in a highly workable form. Adopting the valuable results he has obtained, I intend in the present paper to evaluate certain definite integrals of the nature stated above.

9. Vectorial treatment of angular velocity.

K. KHASTAGIR, Chittagong.

In this paper, it has been proved by Vector analysis that angular velocity of a rigid body is a unique Vector and that angular-velocities are compounded like ordinary Vectors.

10. On the anomalous scattering of α-particles by light atoms.

A. C. BANERJI, Allahabad.

Rutherford and his co-workers found that while scattering of α-particles by heavy elements follows the inverse square law, the observed scattering by light elements (*Al, Mg, He, H*) depart widely from the results predicted from this law. Rutherford and Bieler surmises that when the α -particle is allowed to come very close to the nucleus, the law changes from repulsion to attraction.

Debye and Hardmeier assumed the law to be given by

$$V = \frac{\mu}{r} - \frac{\mu_1}{r^4},$$

where V is the potential energy and obtained modified formulæ which can be fitted to agree with Rutherford's results. Rutherford, however, does not regard Debye and Hardmeier's procedure to be satisfactory.

The above problem has been treated both from classical mechanics as well as from wave mechanics assuming the potential energy to be given by

$$V = \frac{\mu}{r} - \frac{\mu_1}{r^2}.$$

This form is preferred over the Debye-Hardmeier form because the latter does not admit of any solution when introduced into the Schroedinger vibration equation, while the former does. The orbit of the α -particle has been calculated on the classical basis and found to belong to distinct type (i) Region of normal scattering when β (the perpendicular distance from the nucleus on the line of projection) $> ar_0$ where

$$a = \frac{2Ze^2}{MV^2},\ \frac{r_0}{2} = \frac{\mu_1}{\mu}.$$

(ii) when $b^2 < ar_0$ but $> ar_0 - b^2$, the a -particle sweeps round the nucleus and emerges on the same side from which it entered, deflection (iii) when $b^2 < ar_0 - a^2$ the particle falls into the nucleus, and causes breaking up of the nucleus.

The probability W_1 of scattering at an angle θ has been calculated from wave-mechanics, by following Born's method of collisions. If W_0 is the probability on classical mechanics where

$$W_0 = \frac{A}{\sin^4 \frac{\theta}{2}}.$$

$$\therefore \frac{W_1}{W_0} = 1 - B \sin \frac{\theta}{2} + C \sin^2 \frac{\theta}{2},$$

where A,B,C, are certain constants.

The curve given by this formula agrees with the experimental curve given by Rutherford.

11. On the mechanism of radio-active disintegration.

A C. BANERJI, Allahabad.

The mechanism of radio-active disintegration is incapable of any explanation on classical mechanics as has been repeatedly pointed out. Recently Gamow in Russia, and Gourney and Condon in America have shown that Wave-mechanics offers a ready solution to the problem. The main idea is that the nucleus is surrounded at a distance of nearly $10^{-13} cm$ by a potential hill. Within the hill, the a -particle will remain imprisoned for ever, according to classical mechanics, but in wave mechanics it is replaced by a wave which has a finite chance of leaking through the barrier.

The inside of the nucleus may be likened to a region where the refractive index of matter-waves is <1, while in the potential hill it is much >1. It can be shown from conditions of continuity that stationary and damped matter-waves will be produced in the core. The damping of these waves represent the decaying of radioactive atoms.

Kudar, Laue, and Sexl have shown that Gamow's procedure is not mathematically correct, though he has guessed the current form of the solution.

In the present paper the problem has been treated in three dimensions, while the previous authors discussed it only in one dimension, we have assumed the law to be given by V=potential energy

$$= 2Ze^2\left(\frac{1}{r} - \frac{3r_0}{2r^2}\right).$$

This automatically provides a potential hill. It is found within the distance $r < \frac{r_0}{2}$, discrete energy values for -particles are obtained which may account for the γ -ray spectrum. Between $r > \frac{r_0}{2}$ and $< \frac{3r_0}{2}$, damped oscillations are obtained which may be interpreted as radioactive decay.

Beyond $\frac{3r_0}{2}$, the force is repulsive, and any positive value of the energy is possible.

The solutions are compared with known Radioactive data.

12. Flow of water in a porous medium like soil.

N. K. Bose, Lahore.

Flow under conditions in which whole of the pore space in the medium is full, was treated in a paper of mine before the Indian Science Congress and subsequently incorporated in a Memoir of the Punjab Irrigation Research Laboratory. There it was assumed that the flow in such a medium can be replaced by a viscous flow; and the deductions from such an assumption were found to agree very well with Darcey's Law. It has now been possible to verify this assumption more rigorously by tube-well experiments in the Punjab.

13. Recovery contours of subsoil water-table.

N. K. Bose, Lahore.

Cases of sub-soil water-table movement when not in equilibrium have been dealt with; and the rate of creep towards the equilibrium stage has been investigated. From this it has been possible to work out the contours of the unsteady state; and to connect the rate of creep with the characteristics of the soil and the fluid. All these have been done with reference to the cone of depression of a tube-well when pumping had been stopped.

14. Action of a subterranean impervious ridge in heading up the subsoil water-table.

N. K. Bose, Lahore.

It has been found from the Eötvos Torsion Balance Surveys of 1928 and 29 that wherever a subterranean ridge has been located by the Torsion Balance, lands round about it have been already water-logged or are being threatened with water-logging in near future. This coincidence could not be dismissed lightly as being due to chance. So the problem has been attacked from the hydrodynamical point of view and the surprising result comes out that if the depth of the impervious layer at a great distance at right angles to the ridge be 205C. ft. where the depth of W.T. is 50 ft. and the height of the ridge above the level of the distant impervious layer be only 550 ft. the land round about the ridge would be water-logged unless the ground level there is more than 1,578 ft. above the top of the ridge.

15. On a theory of Raman Scattering.

R. C. Majumdar, Allahabad.

Negatively modified scattering was predicted by Smekal and actually worked out in the Kramers—Heissenberg theory of dispersion. The actual credit of discovery goes to Prof. C. V. Raman of Calcutta (1928). At present an extensive literature is growing on the subject, though the theory has not yet been worked out in detail.

It is shown in the present paper that the difference between Rayleigh scattering and Raman Scattering lies in the fact that while the former is due to the action of harmonic oscillators, the latter may be supposed to be due to the action of anharmonic oscillators. A theory of Raman Effect is worked out on this basis, and theoretical formulæ have been obtained for the intensity of Raman Scattering, and for the principle of selection governing the origin of Raman lines. They are compared with experimental results.

16. A Classical Interpretation of Raman Effect.

SATYENDRA RAY, Lucknow.

It is attempted to demonstrate that the Raman Effect is the obtaining of combinational tones in optics and that the quantitative results are not against classical dynamics as presumed by Raman.

17. On a Factorable Determinant with four contiguous non-zero diagonals.

S. C. CHAKRABARTI, Calcutta.

If

$$a_r=\frac{(a^r-1)(a^{r-1}-1)(a^{r-2}-1)}{(a^2-1)(a-1)a^{2r-3}}\left\{\frac{a_0}{a^r-1}-\frac{(a^2-1)a_1}{(a^{r-1}-1)(a-1)}+\frac{aa_2}{a^{r-2}-1}\right\}.$$

$$a_{r1}=-\frac{(a^{n-r}-1)(a^r-1)(a^{r-1}-1)(a^{r-2}-1)}{(a-1)^3a^{3r-4}}\left\{\frac{a_0-a_1}{a^{r-1}-1}-\frac{a(a_1-a_2)}{a^{r-2}-1}\right.$$
$$\left.-\frac{(a^n-a^{n-r+1}-a^{n-r}-a^{n-r-1}+1)(a-1)a^{r-3}}{(a^{r-1}-1)(a^{r-2}-1)}\right\}$$

$$a_{r2}=\frac{(a^{n-r+1}-1)(a^{n-r}-1)(a^r-1)(a^{r-1}-1)}{(a^2-1)(a-1)^3a^{4r-7}}$$
$$\left\{a_0-\frac{a^2-1}{a-1}a_1+aa_2-\frac{(a^2-1)^2a^{n-4}}{a-1}\right\}$$

where a_0, a_1, a_2 and a are arbitrary, then the determinant

$$\begin{vmatrix} x+a_0 & -1 & & & \\ a_{11} & x+a_1 & -1 & & \\ a_{22} & a_{21} & x+a_2 & -1 & \\ & a_{32} & a_{31} & x+a_3 & -1 \\ \cdot\quad\cdot & & \cdot\quad\cdot & \cdot & \cdot\quad\cdot \\ & & a_{n-1,2} & a_{n-1,1} & x+a_{n-1} \end{vmatrix}_n$$

is resolvable into n linear factors of which the *kth* one is

$$x+a_{k-1}+\frac{a^n-a^{n-k+1}-a^{n-k}+1}{(a-1)a^{k-1}}.$$

18. A Factorable Recurrent whose roots are all arbitrary.

S. C. CHAKRABARTI, Calcutta.

Theorem. If

$$a_r=-\beta_r+n-2r-1,$$
$$a_{r1}=(n-r)r(-\beta_{r-1}+\beta_r+1),$$

and if $k>1$,

$$a_{rk}={}^{n-r+k-1}C_k\frac{r!}{(r-k)!}\{-\beta_{r-k}+{}^kC_1\beta_{r-k+1}-{}^kC_2\beta_{r-k+2}+\dots$$
$$+(-)^{k-1}\,{}^kC_k\beta_r\}$$

then the recurrent

$$\left|\begin{array}{cccccc} x+a_0 & -1 & & & & \\ a_{11} & x+a_1 & -1 & & & \\ a_{22} & a_{21} & x+a_2 & -1 & & \\ a_{33} & a_{32} & a_{31} & x+a_3 & -1 & \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n-1,\,n-1} & a_{n-1,\,n-2} & \cdots & a_{n-1,\,1} & & x+a_{n-1} \end{array}\right|_n$$
$$=(x-\beta_0)(x-\beta_1)(x-\beta_2)\dots(x-\beta_{n-1}).$$

19. A Few Factorable Continuants.

S. C. CHAKRABARTI, Calcutta.

1. The continuant

$$\left|\begin{array}{ccccc} \beta_1 & \gamma & & & \\ a_2 & \beta_2 & \gamma & & \\ & a_3 & \beta_3 & \gamma & \\ \cdot & \cdot\;\cdot\;\cdot & \cdot\;\cdot & \cdot\;\cdot & \\ & & a_n & \beta_n & \end{array}\right|_n=(-)^n\frac{(a^{n+2}-1)(a^{n+1}-1)}{(a^2-1)(a-1)}a_1a_2a_3\dots a_n,$$

if

$$a_k=\frac{(a^{n-k+1}-1)(a^{2n-r+k}-a^{n+1}-a^{n-1}-a^{n-r+1}+a^{n-k+1}+1)}{(a^{n-k+3}-1)(a^{n-k+2}-1)},$$

$$\beta_k=\frac{(a^{r+k-1}+a^{r+k-2}-2a^{r-1}-a^{2k-1}+1)a^{2n-r-k+1}-(a^n-1)(a^{n-1}-1)(a+1)}{a^{n-k+2}-1}$$

and

$$\gamma=(2a^{n-1}-a^{n-r}-1)a.$$

2. The identity 1 also holds if

a_k=the same as above

$$\beta_k=\frac{(a^{r-k-1}-1)(a^{k-1}-1)a^{2n-r+1}-(a^n-1)(a^{n-1}+a^{n-r+1}-a-1)}{a^{n-k+2}-1}$$

and

$$\gamma=(a^{n-1}-1)a.$$

3. The identity 1 is also true when

$$a_k=\frac{(a^{n-k+1}-1)(a^{2n-r+k+1}+a^{2n-r+k}+a^{n-k+1}-a^{2n-2r+k+2}-a^{n+1}-a^n-a^{n-1}+1)}{(a^{n-k+3}-1)(a^{n-k+2}-1)}$$

$$\beta_k=\frac{(a^{r-k-1}-1)(a^{r-1}+a^{r-2}-a^{r-k-1}-1)a^{2n-2r+k+2}-(a^n-1)(a^{n-1}-1)(a+1)}{a^{n-k+2}-1}$$

and

γ=the same as in 2.

4. The identity 1 also holds if

$$\alpha_k=\frac{2(a^{n-k+1}-1)(a^{n-r+k+1}-1)}{(a^{n-k+3}-1)(a^{n-k+2}-1)}$$

$$\beta_k=\frac{a^{n-k}-2\,a^{n-r+k+1}+1}{a^{n-k+2}-1}$$

and $\gamma=-1.$

20. A Theorem in Determinants.

S. C. Chakrabarti, Calcutta.

Let us take the array with n rows and $n+2$ columns :—

$$\left\|\begin{array}{cccc} a_t & b_t & c_t & \cdots \\ a_{t+1} & b_{t+1} & c_{t+1} & \cdots \\ a_{t+2} & b_{t+2} & c_{t+2} & \cdots \\ \cdot & \cdot & \cdot & \cdot \\ a_{t+n-1} & b_{t+n-1} & c_{t+n-1} & \cdots \end{array}\right\| \qquad (1)$$

and let ${}^tD_{xy}$ denote the determinant obtained from (1) by deleting xth and yth columns and let A_k be the determinant obtained from

$${}^1D_{n+1,\ n+2}$$

by deleting the first k rows and columns.

Then we have the Theorem :— (2)

If each element of the first column of A_{r-1} be equal to each of the elements which precede it in the row of the determinant

$${}^1D_{n+1,\ n+2},$$

in which it occurs, then

$${}^1D_{2,\ n+2}\,{}^rD_{1,\ n+1}-{}^1D_{2,\ n-1}\,{}^rD_{1,\ n+2}=(-)^{r-1}\,|\,c_1d_2e_3\ldots p_n\ldots\,|\,A_{r-1}$$

where r is a positive integer varying from 1 to n and

$$|\,c_1d_2e_3\ldots p_n\ldots\,|$$

is a determinant of order $n+r-1$, of which the first n columns are formed in the usual way but in the case of the remaining $r-1$ columns, the first n elements of each are the same, viz.,

$$a_1,\ a_2,\ a_3,\ \ldots\ a_n$$

and the last $r-1$ elements are given by those of the corresponding column of the determinant

$$|\,b_{n+1}\ c_{n+2}\ d_{n+3}\ldots\,|$$

of order $r-1$

21. The total eclipse of the Sun on May 9th, 1929.

H. Parameswaran *and* S. P. Venkateswaran, Madras.

A brief account is given of this eclipse to observe which many parties including one from Madras had gone to Siam and its neighbourhood.

22. The Molecular Expansion of Liquids.

M. A. Govinda Rao, Bangalore.

The molecular expansion per calorie of energy has been calculated for several liquids from the available data. The relation between this quantity which is equal to $\frac{\alpha}{\rho c}$ (where α is the co-efficient of cubical expansion, ρ, the density and c, the specific heat) and the structure of the molecule is discussed.

23. Reactions at the Surface of Hot Metallic filaments of Platinum wire coated with barium oxide.

B. S. Srikantan, Bangalore.

In continuation of the previous work, the interaction between carbondioxide and hydrogen has been studied at the surface of a platinum wire coated with barium oxide. The reaction is unimolecular. Carbondioxide has an accelerating effect on the reaction rate up to a pressure of 300 mm. after which it does not affect the reaction. Hydrogen up to 200 mm. has a depressing effect. The temperature co-efficient and the apparent heat of activation have been calculated. Under the conditions of these experiments it has been shown that the active catalyst is a complex $BaCO_3$, BaO.

24. On the mounting of a 300 cms. concave grating and the measurement of the shift in the spectral lines due to a variation in temparature.

S. P. Venkateswaran, Madras.

The paper describes the locally made mounting given to a 300 cms. radius 4″ concave grating in the laboratory. The shift in the lines due to a variation in the temperature in the grating is also measured, and the agreement with the calculated value is showed. The possibility of using this instrument for long exposures is discussed.

25. Porous Pot Evaporimeter.

R. C. Hoon, Lahore.

A simple form of evaporimeter has been designed. A correlation has been established between the rate of evaporation from the porous pot and the varying hydrostatic pressure to which it is subjected.

26. Determination of the direction and rate of the flow of subsoil water.

R. C. Hoon, Lahore.

A simple method based on the application of the thermocouples is developed for finding the direction of flow of water and measuring its rate in the subsoil flow.

27. On the Stark effect in a non-homogeneous field and a possible source of the broadening of spectral lines.

SISIRENDU GUPTA, Calcutta.

Darwin's wave equations which give the Zeeman and ordinary Stark effect in fields of all intensities are well adapted for the consideration of the non-homogeneous Stark effect. Suggestions have often been made that ionised atoms will influence a neigbouring radiating atom by their electric field which cannot be considered to be homogeneous and will give rise to a considerable departure from the ordinary conditions of radiation. By taking a field with cylindrical symmetry of which the potential is of the form $v=a(x^2+y^2-2z^2)$ the energy levels into which the fine-structure levels of a hydrogen-like atom are split up, the lines produced by their combination and their intensities have been calculated. All the fine-structure levels, except the lowest, break up into several whose separations are proportional to the gradient of the field and in the lowest, separations are proportional to the square of the gradient. Two typical groups of lines of $H\alpha$ produced by the combination of the levels for a gradient of the order 10^8 are

No.	Separations, in $\Delta\lambda$ in Å.U., of the Stark components of fine-structure component $j=\frac{5}{2}\rightarrow\frac{3}{2}$
1	·00175
2	—·00007
3	—·00077
4	—·00133
5	—·00203

No.	Separations, in $\Delta\lambda$ in Å.U., of the Stark components of fine-structure component $j=\frac{3}{2}\rightarrow\frac{1}{2}$
1	·0021
2	·00147
3	—·00147
4	— 0021

These figures suggest that the visible effect of the non-homogeneous field will only be a broadening of the spectral lines. This probably applies to a much wider class of spectral lines.

28. On the Absorption Spectrum of the *Hα* Line in the Balmer Series of the Hydrogen Spectrum.

S. P. VENKATESWARAN, Madras.

The absorption in the Fine Structure of the $H\alpha$ line was studied with a capillary discharge tube and a wider one of short length, both in series excited by a transformèr. There was a visible darkening observed in the almost continuous Lummer-Gehrcke interferometer pattern of the capillary discharge when the absorption tube was switched on. A photograph of this was taken and a microphotometric examination of the same showed that it was only a combined effect of the superposition of the light from the source and the absorbing tube. The experiments of Pfluger were repeated. The absorption was also examined with a discharge tube 4½ metres long as the absorbing column.

29. On the construction of a type of partial differential equations of the second order.

H. N. DATTA, Aligarh.

One of the results obtained by Prof. Forsyth in his paper published in the *Proc. L.M.S. Vol.* 5 (1907), may be summarised as follows:—

A partial differential equation of the second order whose primitive can be expressed by a set of equations of the form:

x, y, z = a function of u alone + a function of v alone is of the type $ar+s+ct=0$, and possesses two intermediary integrals of Monge's type when a and c are functions of x and y alone.

In this paper, a method is given of constructing examples in which an equation of the form $ar+bs+ct=dp+eq$ (where a, b, c, d, e are all functions of x and y alone) possesses two intermediary integrals of Monge's type.

30. On the Focal Surface of a Congruence of Curves.

C. N. Srinivasiengar, Bangalore.

(1) Considering the congruence of curves $F_1(x, y, z, a, b)=0$; $F_2(x, y, z, a, b)=0$, there exist a singly infinite number of surfaces of the congruence which do not touch the focal surface.

(2) The envelope of any singly infinite number of surfaces of the congruence forms the focal surface or part of it.

(3) For a special type of congruence, viz., $u(x, y, z)=a$; $v(x, y, z)=b$ where the two systems of surfaces $u=a$ and $v=b$ possess a common envelope, the focal surface in general touches all the surfaces of the congruence without exception. In this case, the focal surface is not the envelope of the curves of the congruence, as is usually the case, but is the locus of their double points.

(4) For the most general type of a congruence of curves, $x=f_1(t, a, b)$; $y=f_2(t, a, b)$; $z=f_3(t, a, b)$, wherein each curve is not the complete intersection of two surfaces, the focal surface does not in general exist.

31. The Study of Organic Vapours as rectifiers.

P. N. Ghosh *and* B. D. Chatterjee, Calcutta.

This paper has two objects. The first is to study the nature of striations which are produced when the vapours are ionised by electrodeless discharge. The second is to find out the ionising potential of these organic molecules and to study their rectification effect on an *a.c.* source. The *e.m.f.* and current waves of a single-phase alternator have been analysed by means of an oscillograph of the Duddel type before rectifying and also when the different vapours are used as rectifiers. From these records, the efficiency of the vapours as rectifiers has been discussed.

32. Radio Signal Fading.

S. K. Kulkarni Jatkar, Bangalore.

Fading effects in short wave radio signals are usually of a periodic nature with superimposed rapid fluctuations. These are usually explained by the absorption of the signals by ionised clouds or by the wavy character of the Kennelly Heavyside layer.

During the course of the measurement of velocity of supersonic sound in gases and vapours the author obtained curves of very complex nature, for the interference between direct waves from the piezoelectric quartz crystal and those reflected from a comparatively wide flat plate moved parallel to the face of the crystal.

The very striking resemblance between these curves and radio signal fading curves leads the author to suggest that both the periodic fading and the existence of rapid flickering noticed on short waves may be due to the regular movement of the ionised layer alone. Attempts are being made to calculate this rate of movement from published data.

33. Potential acquired by a flame collector in a constant Potential Region.

A. VENKAT RAO TELANG, Bangalore.

The flame of an oil lamp or gas lamp has often been used as an "equaliser" or collector of potential in the measurement of atmospheric electric fields. Its action has been discussed by M. Moulin (in the *Annal. d. Chem. e. Phys.* in 1907). E. R. V. Schweidler has dealt with the currents discharged by flames (in the Wien Akad Sitzber, 1898). But no definite work has been published nor opinion expressed as to whether a flame takes up in the steady state the correct potential of the region in which it is placed.

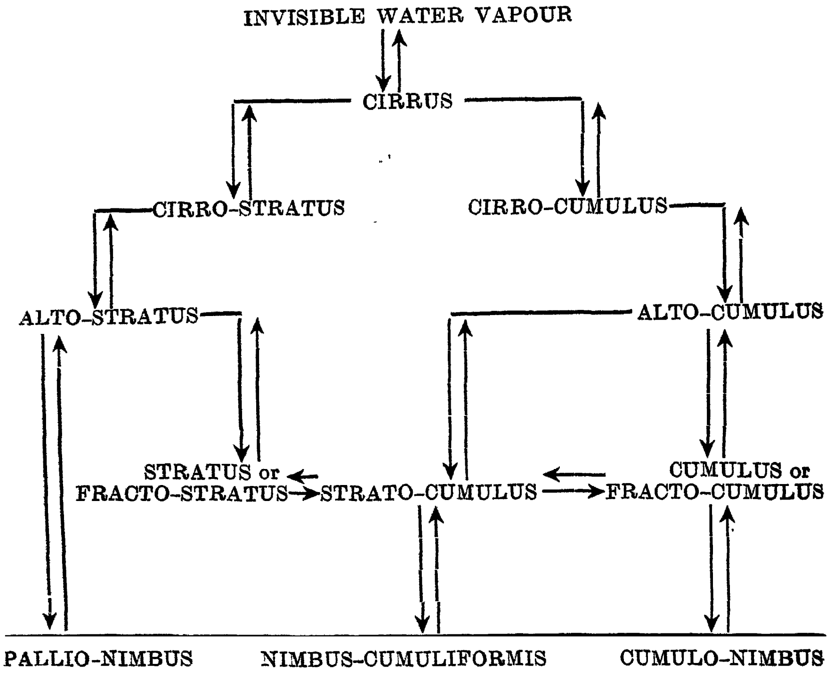
In the course of a series of experiments to compare the performances of different kinds of collectors certain observed irregularities indicated that, the potential acquired by a flame collector may not be the same as the potential in the region in which it was placed. Experiments were then conducted by placing an insulated gas-jet in an insulated Faraday case, which could be charged to any desired potential. The potential acquired by the flame in the steady state was measured by connecting the metal jet to a quadrant electrometer.

It was found that the flame always acquired a potential in excess of that of the case, the excess depending on the height of the flame, and to some extent on the potential of the cage, *e.g.*, when the cage was at zero potential, the excess varied from about 6 volts for a very small flame (about 3 mm. high) to 1.38 volt for a tall flame (about 15 cms.). Again with a flame about 7 mm. high the excess varied from 2.96 volts at zero volts on the cage to 2.19 vts. for about 7.8 volts on the cage. An explanation of the phenomenon is offered.

34. Evolution of Clouds.

S. C. ROY, Poona.

This paper discusses the physical processes of formation of clouds. The growth and decay of different types of clouds is summarised in the following diagram :—



The following three types of evolution of clouds are common in India :—

(*a*) Cirro-Stratus→Alto-Stratus→Pallio-Nimbus, *i.e.*, a continuous sheet of Nimbus and Alto-Stratus which causes light rain or drizzle. This sequence of cloud growth is often seen in front of a winter disturbance and is caused by a *gentle* rise of moist air over land air.

(*b*) Cirro-Cumulus→Alto-Cumulus→Strato-Cumulus Nimbus-Cumuliformis, *i.e.*, a bank of Nimbus with considerable vertical extensions which usually gives heavy rain. This sequence of cloud growth is usually seen in front of a cyclone of the transition periods or of a depression of the rainy season and is due to the *spontaneous* uprise of moist oceanic air which is practically saturated with moisture and has a lapse rate near the moist adiabatic. This air mass is *thermodynamically unstable* and as soon as its dynamical stability is destroyed by conflict with another air-current or by deflection near a range of hills, the oceanic air continues to rise until it loses all its moisture by condensation.

(*c*) Cirro-Cumulus→Alto-Cumulus→Cumulus→Cumulo-Nimbus or thunder-shower cloud. This sequence of cloud growth which is associated with *thermal convection* is well-known.

(*d*) Stratus or Alto-Stratus (Morning)→Strato-Cumulus→Cumulus (Afternoon). This sequence is noticeable in north-east India during the hot weather months. The stratiform clouds in the morning are associated with an *inversion* over Bengal. With the setting in of turbulence in the air after sunrise, the inversion gradually disappears and cumuliform clouds appear in the afternoon owing to thermal convection.

35. A simple method for the measurement of the speeds of photographic shutters.

H. Parameswaran *and* G. P. Krisnamurthy, Madras.

The paper describes a simple method for the purpose using no complicated apparatus beyond the camera itself. An illuminated point falling along a scale when photographed registers itself as a track by the side of the scale. The duration of this can be calculated easily by measuring the length of the track and applying the fall plate method. The results obtained are in good agreement with those obtained by other more complicated methods.

36. An alignment adjustment for spectrometers.

H. Parameswaran, Madras.

The paper describes a method of adjusting the alignment between the axis of rotation of the prism table and telescope, and the collimation axis of the telescope and collimator. A large number of even high grade Hilger instruments examined showed this error. The errors in measurement due to this as well as a simple attachment to the spectrometer by which to adjust the spectrometer to eliminate this error are described.

37. The yield effect in pitch polishers and its consequences

H. Parameswaran, Madras.

During the figuring of any large optical element the pitch of the polisher yields. The magnitude of this is interferometrically determined and its possible effects on the further use of the polisher are discussed

38. The amplification of small Direct Currents with a Thermionic Valve.

Bh. S. V. Ragahva Rao *and* H. E. Watson, Bangalore.

The optimum conditions for the amplification of small currents by thermionic valves has been investigated and the current magnification for a number of valves of different types has been deduced from measurements of grid current and anode current characteristics. The results agree with the relative values obtained when using a silver photo-electric cell as a standard source of current. The conditions for the best results are, (*i*) good insulation of the grid, (*ii*) high mutual conductance, and (*iii*) low impedance. The performance of a valve can generally be improved by working it at a greatly reduced anode and filament voltage. The magnification is higher when the grid is charged negatively than when positively, but in the latter case the magnification is constant over a wider range, which is essential when comparing different currents. The highest magnification measured was with a Philips *B* 405 valve at 30 volts anode potential, being 5×10^3 for a current of 5×10^{10} amp. and higher values can be obtained by use of a subsidiary cell to bias the grid.

39. Measurement of Valve Parameters.

T. S. Rangachari, Bangalore.

A modification of Miller's method is described which enables the measurement of the amplification factor and anode-filament resistance of thermionic valves to a greater degree of accuracy. Experimental results are given employing the modified method.

40. A theorem concerning integral functions of order unity and type positive.

P. L. Srivastava, Allahabad.

The main theorem established in this paper is the following:—

Theorem :—In order that for an integral function

$$\phi(z)=\sum_{0}^{\infty}\frac{c_n z^n}{n!}$$

of order 1 and type K, $K>0$, the minimum value of

$$\lambda(\psi)\equiv\overline{\lim_{\rho\to\infty}}\frac{\log|\phi(\rho e^{i\psi})|}{\rho},\ (\text{for } |\psi|\leqq\pi),$$

should be negative, it is both necessary and sufficient that there should exist an integral function $c(z)$ of order $(e^{L\rho})$, where L is a constant, satisfying the following two conditions —

(*a*) $$c(n)=c_n,\ (n=0,1,2,3,..),$$

(*b*) $$0\leqq H\left(\frac{\pi}{2}\right)+H\left(-\frac{\pi}{2}\right)<\pi,$$

where $$H(\psi)=\overline{\lim_{\rho\to\infty}}\frac{\log|c(\rho e^{i\psi})|}{\rho}$$

I believe this theorem has not been noticed before.

41. On a theorem of H. Cramér.

P. L. Srivastava, Allahabad.

In a paper of his entitled '*Un theorème sur les séries de Dirichlet*' in *Arkiv* (Bd. 13, 1918), Dr. Cramér proved a beautiful theorem on Dirichlet's series, basing his proof on a property of an absolutely convergent double series. Another proof of this theorem has been suggested by means of a formula mentioned on page 228 of *Jahrbuch*, Bd. 49. In this paper I obtain a more natural form of this formula and then show how it enables us to generalize Cramér's main theorem and some of the results deduced therefrom. The following two are the chief results.

(1) If $\Sigma\frac{1}{\lambda_n}$ is convergent, then the function

$$h(s)=\Sigma a_n e^{-s\lambda_n}$$

can have no finite isolated singularity, nor can it be expressed as the sum of two functions, one integral, and another regular at infinity, but not identically a constant.

(2) Suppose there exists a Dirichlet's series

$$\Sigma a_n e^{-s\lambda_n}$$

whose sum-function has a finite isolated singularity at $s=s_0$ on the convergence-line, and is expansible in Laurent's series for

$$0<|s-s_0|<\delta.$$

Then an integral function $\phi(z)$ satisfying

$$\left| \phi(\rho e^{i\psi}) \right| < e^{\rho(\lambda(\psi)+\epsilon)}, \ (|\psi| \leqq \pi, \epsilon > 0),$$

where $\lambda(\psi)$ is continuous, and $p=\lambda(\psi)$ is a closed convex curve, the distance between any two points on which is less than δ, is identically zero, if

$$\phi(\lambda_n)=0, \ n=1, 2, \ldots$$

42. New Light on the Indian Cyclic Method—an investigation in the theory of the reduction of Quadratic forms.

A. A. Krishnaswami Iyengar, Mysore.

It is the object of this paper to bring out at some length the true inwardness of Bhaskara's Cyclic method for solving indeterminate equations of the form $X^2-Ny^2=1$. The true nature of the cyclic method has been misunderstood by many eminent authorities including H. T. Colebrooke, H. J. Smith, T. L. Heath, who are under the impression that it is the same as that re-discovered and expounded by Lagrange, six hundred years later than Bhaskara. The present investigation reveals that Bhaskara's method is not the same as Lagrange's reduction method, nor is it identical with Euler's solution by the process of converting $\sqrt{N}$ into a simple continued fraction, but it appears to be more comprehensive than these including them as particular cases. The Indian method leads naturally to a new set of reduced quadratic forms (distinct from those of Gauss, Lagrange, Klein, and Hermite), which correspond to the successive convergents of an irregular continued fraction containing a lesser number of recurring elements than the equivalent simple continued fraction.

43. A note on Doppler effect and the Hypothesis of radiation quanta.

D. S. Kothari, Allahabad.

The Doppler-Fizeau effect, which has been so widely applied in several astrophysical problems is easily explained if radiation is considered to be propagated in the form of waves. In this note it is explained from the point of view of quanta. It is further shown that Compton effect is a particular case of Doppler effect. The idea of minimum observable length (h/mc) is interpreted from this point of view.

44. A note on Doppler effect in relation to atoms.

D. S. Kothari, Allahabad.

In the previous note the Doppler-Fizeau effect has been explained on the hypothesis of radiation quanta and its relation to Compton effect has been indicated. In this note the same subject is discussed with regard to material atoms and not radiation. It is shown that in the case of atoms when they are replaced by their De-Broglie waves, we have effects analogous to those in the case of radiation. Quanta and atoms do not differ from each other so far as Doppler, Compton, and Raman effects are concerned, the degrees of freedom of a quantum are discussed from the above point of view.

45. Life of excited atoms.

D. S. Kothari, Allahabad.

The life of excited atoms is calculated from analogy with the damping of a Hertzian oscillator. For wave-lengths of about 1μ, this comes out of the order of 10^{-8} sec. In this note the above method is modified and a different formula is obtained for the life of excited atoms. The problem of the life of metastable atoms—which is about a million times larger than the life of an ordinary excited atom—is also considered and a formula is derived by regarding the metastable atom to be a closed oscillator. The calculated value is of the right order of magnitude. A possible mechanism is also suggested to account that in some cases a life of the order of some minutes is observed.

46. The electric field of overhead thunderclouds.

S. K. Banerji, Bombay.

During the last one year, some interesting observations were made of the electric field of overhead thunderclouds. The experimental equipment consisted of two Bendorf's self-recording electrometers joined to a double-nozzle water-dropper and ionium collector respectively. The insulations received constant attention, so that the two instruments gave almost identical records of the changes in the electric field. Thunder-storms of the line-squall type occasionally pass over Colaba Observatory during the pre-monsoon and post-monsoon months, during the burst of the monsoon and also during weak monsoon periods. They generally move from the sea towards the land and may occur at any time during day or night. Several thunderclouds of this kind passed over the observatory during the months, March to June, of this year. They were unitary thunderclouds and all of them gave very similar records of field changes. When the front part of the cloud was overhead, the field became negative of several thousand volts per metre, when the central part came overhead, it quickly changed to equally high positive, and when the rear of the cloud was overhead, it became again strongly negative, reverting to normal positive gradient after the cloud passed away. The intensity and duration of the changes were different in different thunderclouds but the sequence was identical. The changes suggest that the front part of such clouds is negatively charged, the central part positively charged and the rear negatively charged agreeing with Simpson's breaking-drop theory. These observations are distinctly at variance with those of Schonland, who noted that the passage of an active storm invariably produced strong and persistent negative field below it.

The afternoon thunder-storms, commonly known as 'heat thunder-storms', usually form over the hills to the east of the observatory, and when fully developed, invariably pass over it. Several such thunder-storms passed over during September and early part of October of this year. Some of them are found to be of 'unitary type' and others of 'double type' and 'multiple type'. The unitary type produced changes in the electric field similar to those described above, but in the double and multiple types, the sequence of changes was repeated as if two or more thunderclouds of unitary type passed in succession. It was observed also that the electric field of ordinary monsoon clouds, showing no lightning flashes, was predominantly negative. The observations have been discussed in the paper with special reference to the structure of thunder-clouds.

47. Eddy viscosity and sea waves.

S. K. Banerji, Bombay.

The values of eddy viscosity obtained by Taylor and others from the variation of wind with height, from the loss of momentum with respect to height and the speed of ascent of cumili, vary within such wide limits and in such irregular manner that it is difficult to form any idea as to its magnitude or the laws of its variation. Its value very close to the sea surface was required by me in connection with certain computations of evaporation from the Indian Seas and was determined in the following manner. From the hydrodynamical theory of generation and maintenance of waves against viscosity, we can easily prove that a wave system of the type $\eta=a\ \sin\ (\xi x-pt)$ can be maintained by a purely tangential force $T=\text{const.}+4\mu\xi pa\ \sin\ (\xi x-pt)$, where $p^2=g\xi \tanh \xi d$, η is the elevation, $2\pi/\xi$ the wave-length, $2\pi/p$ the period, d is the depth of the sea, and μ the co-efficient of eddy viscosity. Theoretical considerations as well as measurements of the skin friction of the wind on the earth's surface suggest that $|T|=0{\cdot}0025\ \sigma V^2$, where V is the velocity of wind and σ the density of air. We thus get $4\mu\xi pa=0{\cdot}0025\sigma V^2$. For maintained waves, the velocity of waves is only slightly less than the velocity of wind. The following table gives the value of μ/σ deduced from this formula, using for the heights of the waves the average observed values.

Class of sea waves.	Wind velocity (m.p.s.)	$\frac{2\pi}{\xi}$ (m.)	$\frac{2\pi}{p}$ (secs.)	Height of Waves (m.)	$\frac{\mu}{\sigma}$
Very Rough ..	18·0	198·2	12·0	7·75	$15{\cdot}7\times 10^3$
Rough ..	14·2	129·6	9·1	5·05	$7{\cdot}5\times 10^3$
Moderate ..	10·7	76·3	7·0	3·55	$2{\cdot}7\times 10^3$
Slight ..	6·7	30·5	4·4	1·60	$0{\cdot}6\times 10^3$

48. On the isobaric and isothermal surfaces in the atmosphere.

S. K. Banerji, Bombay.

To explain from theoretical consideration the configuration of isotherms in the first 25 kms. of a vertical section of the atmosphere of the globe, as given in Sir Napier Shaw's diagram, corrected and amplified by Dr. Ramanathan (*Nature*, June 1, 1929), one has to note that these represent the average conditions and therefore, the most stable configuration which they can attain under the forces acting on the atmosphere. For attaining the greatest stability, the isobaric and isothermal surfaces must coincide. Until they do so, there will be a vertical gradient of wind and Richardson's criterion of turbulence for adiabatic lapse rate, which holds under the average conditions in the troposphere, shows that turbulence will be generated tending to make the surfaces coincide with each other. Since turbulence always exists in the atmosphere, the coincidence is never attained, but when averaged over, the surfaces must be very similar and close to each other. Under such conditions, the isobaric surfaces, taking the earth's rotation and gravity into account, are given by

$$P=289\,.\,\frac{2r}{R}-\left(1+\frac{2r}{R}\right)\sin^2\theta+\text{const.}$$

where P=pressure in C.G.S. units, R=earth's radius, r=vertical height above earth's surface, and θ=angle at the earth's centre measured from polar axis. The isothermal surfaces in the troposphere are determined by convective equilibrium, consistent with the distribution of temperature in the earth's surface and that in the tropopause as given by radiative equilibrium. When both set of surfaces are plotted, it is noticed that for coincidence, the isothermal surfaces must shift upwards over the equatorial region and downwards over the polar region. The process makes the air in the neighbourhood of the tropopause over the equatorial region to have the lowest temperature. When the isothermal surfaces make a close approach to the isobaric surfaces, they show a fair agreement with those given in Dr. Ramanathan's diagram. The ring shaped isothermal surfaces surrounding the ring of coldest air is a consequence of the existence of an isothermal layer surrounding the globe at a height of about 40 km. and at a temperature above that of the tropopause due apparently to ozone (Proc., Roy. Soc., Vol. 125A, p. 292, 1929).

49. The Structure of the Madras Storm of January, 1929.

K. R. RAMANATHAN *and* A. A. NARAYANA IYER, Poona.

A storm of moderate intensity crossed the Madras Coast a few miles south of Madras on the 7th January, 1929. A study of the available data shows that the storm was formed at the interface of a warm moist south-easterly current of air from the south-east of the Bay with the comparatively colder and drier air originally of land origin, but moistened in its lower layers by passage over the Bay. A typical extensive "warm" front was associated with the storm.

50. Conditions which determine the place of origin of storms in the Bay and their direction of movement.

K. R. RAMANATHAN, Poona.

(1) It is well known that the place of origin of the storms in the Bay has a more or less regular annual oscillation, being near the head of the Bay in July and August and in the extreme south of the Bay near the latitude of Ceylon in January. Charts of normal isobars, winds, and isosteres at 1 and 2 kms. prepared by Mr. P. R. Krishna Rao in the Upper Air Section at Poona show that storms have a tendency to form in such places where the air of higher of lower density and moisture content than is normally to be found in those places tend to collect and get placed in contact with fresh air generally coming from some more southerly latitude. In May to September, warmer and drier air tends to be imported from land into the Bay and in November and December, colder and drier air. One would expect from this that instability and thunder-storms would be normal features of the storms of the former season, and warm fronts and associated rains of those of the latter. Experience confirms this.

(2) It has been shown by Dr. Harwod that storms and depressions in India have a tendency to move in the same general direction as the winds at the Ci level. Later data support this although from the nature of the case, it is difficult to get conclusive evidence from the data of individual storms. Results of sounding balloon ascents at Agra show that during the monsoon months, temperatures are very high between 6 and 12 kms. and the reason for this is that the rate of fall of temperature with height above low cloud level is small in this season as the temperature follows more or less the curve of saturation adiabatic. If we accept that the effect of large rainfall is to raise the temperature of the upper air between the above-mentioned levels and if the distribution of wind in the vertical is such as to carry this warm air in any particular direction, pressure will begin to fall in that direction thus directing the movement of the storm. According to this view, the role of the upper winds is mainly directive ; whether the storm will strengthen or weaken will depend on conditions in the lower layers.

51. The Perihelion Motion of Mercury.

SATYENDRA RAY *and* NALINI NATH BOSE, Lucknow.

By the addition of a cube law to the inverse square law in the expression for the force between nucleus and planet, in a manner analogous to atomic dynamics of J. J. Thomson, it is shown that within the limit of accuracy of astronomical determination of perihelion motion as recorded, this motion can be explained.

52. X-ray Investigation of Coloured Potassium Chlorate Crystal.

S. C. SIRKAR, Calcutta.

It is well known that during crystallisation of potassium chlorate from solution, beautiful iridescent crystals are very often found. The late Lord Rayleigh put forward a mathematical theory and showed that the phenomena could be explained by assuming reflection of light from a number of planes of twinning and countertwinning placed at almost regular intervals inside the crystal. The same theory could also explain beautifully the abnormal reflecting power of potassium chlorate crystals heated almost to its melting point and then cooled, as first observed by Madan. The present Lord Rayleigh has examined both coloured and heated potassium chlorate crystals under microscope using polarised light and has actually shown the existence of such twin plane inside these crystals.

In the Laue photograph of a coloured crystal obtained by passing X-rays nearly normal to the 001 face (referred to crytallographic axes), some of the spots are observed to be doublets. A single crystal gave single spots but on heating the same crystal, most of the spots in the Laue photograph became double. Determination of the size of unit cell showed that some of the planes of one component of a twin crystal made an angle of about 1° with some of the planes in the other component and these pairs of almost parallel planes produced Laue spots very near to each other. So X-ray investigation also shows the existence of twin planes in the coloured and heated crystals. The position of atoms in the unit cell has been found out from oscillation photographs and an attempt has been made to explain why this crystal twins so easily and why the layers are placed at such regular intervals.

53. X-ray Diffraction by Liquid Hexamethyl Benzene.

P. KRISHNAMURTI, Calcutta.

Hexamethyl benzene crystallises in the triclinic system, and the recent work of Mrs. Lonsdale (Proc. Roy. Sec., A 123, 494 (1929) shows that it contains only one molecule per unit cell, and that all the carbon atoms in the molecule lie in the same plane [001]. This plane has the largest structure factor and hence its reflection is very strong. It could be seen from a model of the crystal that the thickness of the benzene ring is 3·7 A.U., the spacing of the 001 plane.

The liquid pattern taken with the K radiation of Copper showed the presence of two rings at 8·2 and 4·2 A.U. respectively. The inner ring corresponds roughly to the (100) reflection of the crystal and the fainter outer ring to the (001) reflection. It is therefore quite probable that the outer ring is due to the thickness of the molecule, and the inner ring to periodicities in the plane of the molecule. This is in general agreement with the views put forward by the author in a previous paper (Ind. J. Phys. *3*, 225 (1928) in the case of ortho and meta di-substituted benzene derivatives.

54. Solution of a system of linear equations of an infinite number of variables and its relation to some theorems on differences of non-integral order. ('Mehrfach' Monotone sequences.)

K. S. K. IYENGAR, Bangalore.

(*a*) If $v_n > 0$ and $v_n \to 0$ $n \to \infty$ and $a_n > 0$ and $\sum_1^\infty a_n = 1$ and

$$v_n - \sum_1^\infty v_{n+\rho} a_{n+\rho} = \psi(n) > 0 \text{ for all } n.$$

Then $\underline{\underline{v_n = \psi(n) + b_1\psi(n+1) + b_2\psi(n+\Sigma) +}}$ $\;!\;!\;!$

where $b_n = a_1 b_{n-1} + a_2 b_{n-2} + \;\cdot\; + a_n b_0$ and $b_0 = 1.$

Deductions.

(*b*)

(1) If $\nabla^r v_n > 0$ and $v_n > 0$ and $v_n \to 0$ $n \to \infty$
then $\underline{\underline{\Sigma n^{r-1} \nabla^r v_n \text{ is convergent.}}}$ $(0 \angle r \angle 1).$

(2) If Σv_n is convergent

and $v_n > 0$ and $v_n - \sum_1^\infty v_{n+\rho} a_{n+\rho} = \psi(n) > 0$ for all n,

Then $Bn\underline{\underline{[\psi(n) + \psi(n+1) + \;.\;.\;]}} \to 0$

when $n \to \infty$

where $B_n = b_0 + b_1 + - + b_{n-1}$ (where the b_n and $\psi(n)$ are as in (*a*))

A particular case of this being a Theorem of Knopp. (Zeitshrift 1925, Vol. 22) namely

If Σv_n is convergent $(v_n > 0)$ and $\nabla^r v_n > 0$ for all n $(0 \angle r \angle 1)$
then $n^r \underline{\underline{\nabla^{r-1} v_n \to 0}}$ $n \to \infty$

(3) Another theorem of Knopp's namely
If $\nabla^r v_n > 0$ for all n and $r^1 \angle r$
Then $\underline{\underline{\nabla^{r^1} v_n > 0}}$ for all n, can be easily deduced and extended.

55. A note on a theorem of Cesaro's and Mercer's limit theorem (extended form).

K. S. K. IYENGAR, Bangalore.

If $v_n > 0$ and $v_n - v_{n+1} > 0$
for all n and $v_n \to 0$ $n \to \infty$
and $\Sigma a_n v_n$ converges then $s_n v_n \to 0$ $n \to \infty$
where $s_n = a_1 + a_2 + \ldots\ldots + a_n.$

A new proof of this theorem is given wherein it is shewn that it can be easily deduced from Mercer's limit theorem.

56. A note on some "Pringsheim," tests of Convergence for positive series.

K. S. K. IYENGAR, Bangalore.

57. The Effect of Ultra-violet light on the Electrical Conductivities of the liquid Alkali-Metal Amalgams.

D. BOOHARIWALLA, Bombay.

Ries (Phys. Zeits., XII, *530*, 1911) has shown that the electrical conductivities of metals do not change when the metals are exposed to light. Herrmann (Verh. d. Deutsch. Phys., XIV, 573, 1912) has also found that the electrical conductivities of metals and alloys do not change when they are exposed to ultra-violet light.

The author has studied the effect of ultra-violet light on the electrical conductivities of sodium and potassium amalgams and has found that there is no change in the conductivity, measured in darkness and in light. It appears, therefore, probable that amalgams behave like alloys of sodium and potassium with mercury.

58. Mechanical action on a metal ring due to an Electromagnet traversed by varying currents.

ABINASHCHANDRA SAHA, Rajshahi.

A flat aluminium ring is placed near the end of an Electromagnet, and the mechanical effect on the ring is studied under various conditions. The following are the results of an experimental investigation—

1. At make of current—repulsion 2. At break of current—attraction	For the same value of current:—the repulsion is stronger than attraction.
3. When the current is rapidly made and broken—	
(*a*) by passing through a mercury jet interrupter—	The repulsion predominates. The ring is strongly pushed away. If not allowed to move away,—the ring vibrates according to the frequency of the interruptions.
(*b*) by passing through an electrolytic interrupter—	The repulsion is stronger than before.
4. When an alternating current is passed—	The repulsion is more powerful. (Elihu Thomson effect.)

To produce the Elihu Thomson repulsion of a metal ring by an electromagnet, an alternating current supply is not absolutely necessary. The passage of a rapidly intermittent current is enough for the purpose.

59. Photo-voltaic Cells with Fluorescent Electrolytes.

Bh. S. V. RAGHAVA RAO, Bangalore.

The Photo-E.M.F. of a Pt | erythrosin | Pt cell has been measured using a thermionic valve voltmeter, which overcomes many of the disadvantages of usual potentiometric method, a mercury arc being the source of light. The steady potential of the cell increases at first with the concentration of the dye in solution, reaches a maximum and then falls off slowly. The maximum potential measured was 18 millivolts with a 0·275 per cent. solution.

The effect of varying the intensity and wave length of the incident light has also been studied.

60. Statistical interpretation of Einstein's derivation of Plancks' Radiation Formula.

R. C. Majumdar, Allahabad.

Bose in Zs. f. Phys. Vol. 27 made an attempt to deduce the Plancks' Radiation formula without the conception of Einstein's Negative absorption. Though there had been no mistake in his final formula, Einstein criticised his procedure with the remark that Bose got the probability of absorption to emission

$$A\nu \mid A\nu+N\nu : \mid$$

This requires the omission to be independent of incident radiation and thus violating the classical principles. The anomaly, as we understand, was due to the fact that Bose in his procedure considered only the Mechanism of absorption but not that of emission, which when we take into account, meets the criticism satisfactorily giving the ratio of absorption to emission

$$A\nu : A\nu+N\nu$$

the same as demanded by Einstein.

61. A constant current method of modulation in *wireless telephony.*

S. R. Kantebet, Bangalore.

The common method of modulation known as choke or constant current modulation, has an important objectionable feature in that the choke impedance is far from being uniform over a wide range of audio frequencies. Consequently modulation suffers at the extreme audible frequencies now coming into use. In this method, the choke in the common power lead to the modulator and the oscillator valves is replaced by a saturated diode. The diode being in the nature of a pure resistance at all audio frequencies, considerably improves modulation. Comparative performance curves using both the systems of modulation are given.

62. A short period study of the Bombay Broadcast *reception in Bangalore.*

M. N. Doraswamy, Bangalore.

The paper gives details of the methods of measuring modulation ratio, signal strength, and fading at broadcast frequencies.

Figures obtained for the Bombay Transmissions on 357·1 meters are given.

63. Transverse Waves in "Ether" Gas.

Satyendra Ray, Lucknow.

From the variability of Avogadro's Number, (Zeit. f. phys. Chemie, 128, 182, 1927) it is shown that if ether is excessively "finegrained", it can carry transverse light waves, while behaving as a perfect fluid for astronomical motions for all practical purposes.

64. Longitudinal Tremors in Thomson's super-dispersive medium.

Satyendra Ray, Lucknow.

From Sir J. J. Thomson's investigation it is shown that a super-dispersive medium is capable of carrying longitudinal waves.

It is believed that this explains the Kothari and Gogate results (I.J.P., Aug., 1929) and the explanation furnishes a simple mathematical derivation of Yagi's formula.

65. Hartmann's Formula and the Theory of Errors.

SATYENDRA RAY, Lucknow.

C. S. Bhatnagar drew author's attention to the infinitely better values of wave length as found from a simple law of proportionality or by a graphic method of interpolation. The author shows that the formula is experimentally very unfortunate in form, and proposes that a formula of the type used in thermometry would be very much more useful.

66. A note on Stefan's Law.

SATYENDRA RAY, Lucknow.

At the last Congress experimental results of H. L. Tandan, Ram Saran, and Brij Behari Lal were reported. The author believes the discrepancy is due to theoretical difficulties. Stefan's Law was, originally, an empirical formula in the manner of Newton and Dulong and Petit's laws of cooling. It is shown that Denning's formula cannot be theoretically true. It is shown that in a Hohlraum the temperature cannot be constant unless the density of ether varies with co-ordinates. Experimental results of Mr. Ram Saran are given.

67. The Einstein-Jager derivation of Brownian Movement.

T. P. GAURGAS, Lucknow.

It is shown that the probability expression used must involve time just as well as the distance travelled, and if we make this correction we do *not* get the Verschiebungsquadrat increasing with time as it does in the accepted formula. This is in consonance with Svedberg photographs.

68. A Generalisation of the Equation of Wave Motion for Dispersive Media.

T. P. GAURGAS, Lucknow.

A kinematical generalisation is given, capable of expressing waves we meet with in investigation of group wave velocity. de Broglie's relation $uv=c^2$ is satisfied, as a special case, when the parameter l is equal 2.

69. Raman's classical deriction of the Compton Effect.

SATYENDRA RAY, Lucknow.

It is shown the splitting up of into I_1 and I_2, as done by Raman does not give (1) a steady and (2) a variable effect at all, inasmuch as F^2 occurs in both the components. It is easy to divide I into two such parts, and this is done in the paper. It is shown that the really variable part so obtained is, within a small percentage error, identical with the so-called steady effect of Raman's analysis.

70. A Question of Relativity.

SATYENDRA RAY, Lucknow.

Einstein presumes that the most careful observations have never revealed anisotropic properties in terrestrial physical space, *i.e.*, a physical non-equivalence of different directions.

If, however, a railway train travel north and south from Dehra Dun or Poona, it would, on account of the speroidal shape of the earth, cause the moment of inertia of the earth to change, and therefore alter the angular velocity of the earth. The mechanical energy changes will produce alteration in the terrestrial *electric* and *magnetic* fields, explaining the latter and furnishing relativists with the "anisotropy" that they

71. An Envelope in Modern Geometry.

M. Venkatarama Iyer *and* M. Bhimasena Rao, Bangalore.

Prof. H. G. Grace, M.A., F R.S., in a paper 'On Fauerbach's Theorem' (J.I.M.S., Vol. IX, No. 3) has shown that 'If the major axis of a conic inscribed in a triangle passes through the circumcentre, its auxiliary circle touches the N.P. circle', and has added that 'The other part of the envelope is rather complicated and might be suggested as a matter for consideration'.

In this paper, the equation of the complete envelope has been obtained a quadricircular Octavic of which the N.P. circle forms a factor. The equation of the tricircular sextic is also given in full, using Darboux's tetracyclic co-ordinates. A nice property of this sextic is also noticed.

72. A Question of Geometry.

Satyendra Ray, Lucknow.

On account of Gogate's paper on a "serious difficulty in Cotter's treatment of Quantum Phenomena". Prof. Cotter has altered the treatment in the new edition of Preston's Theory of Heat, presenting Mr. Gogate a copy of the book. It is submitted that the "difficulty" is only increased in the new treatment and not removed.

73. Experiments made to imitate the common practice (technically known as Abataran Ash) of exciting the string of the Indian musical instrument 'Vina' have yielded the result that the original high frequency oscillation gets nucleated in pulses which move to and fro between the ends of the string. These pulses produce the peculiar musical effect characteristic of the art.

D. Banerji *and* R. Ganguli, Calcutta.

74. The Velocity of High Frequency Sound in Gases and Vapours.

S. K. Kulkarni Jatkar, Bangalore.

Using weak oscillations and a narrow tube (15 cm. x1 cm.) improved waveform in the ultrasonic radiation from piezoelectric crystals has been obtained and velocities at 50,000 cycles for air, carbon dioxide, methyl and ethyl alcohols, methyl and ethyl ethers, acetone, chloroform, and carbon tetrachloride have been determined at 97·5° and 134·5°.

75. On certain characteristic of Tuning Forks made of Glass Tubing.

L. Sibaiya, Bangalore.

The variation in frequency of a hollow pyrex glass tuning fork containing liquids of varying densities has been studied. The linear relation between the density of the liquid filling the fork and the reciprocal of the square of the frequency, theoretically deduced, is verified.

The feasibility of determining the frequency of a note from the gradual alteration in pitch of the fork caused by filling its prongs with some liquid to various heights is suggested.

Young's Modulus of pyrex glass, calculated by this acoustical method, agrees within limits of experimental error with that given by Corning Glass Works.

A possible method of evaluating the viscosities of liquids from a study of the damping co-efficients of the liquid-filled fork is indicated.

76. New methods in Statistical Mechanics.

R. C. Majumdar, Allahabad.

Saha and Sur in Phil. Mag., Vol. 1, p. 280, arrived at the probability expression

$$W=G/G_0=G/h^{3N}.$$

The calculation for G the phase volume in $6N$ dimensional space, is then reduced to that of a 6 dimensional space gs, and is expressed as

$$G=\frac{N!}{\Pi\, Ns!}\,\Pi\, gs^{Ns}$$

The expression for Entropy

$$W=\frac{1}{\Pi\, Ns!}\,\Pi\, as^{Ns}$$

when combined with $S=K\log W$ lead to some interesting results. When we make the Vander Waals correction in 6 dimensional space Gs, assuming the phase volume of a molecule to be h^3, we get the Fermi-Dirac statistics and neglecting which gives the classical statistics. But to get the Bose Einstein statistics we are to put the phase volume of the quantum or the molecule equal to $(-h^3)$.

77. A review of recent theories of electric conduction, and a description of certain experiments undertaken for testing them.

G. R. Toshniwal, Allahabad.

A review is given of recent theories of electric conduction, particularly of the theory of Sommerfeld, which is based on Fermi-statistics, and of its extension by Houston, Bloch, and others from the point of view of wave mechanics. A critical review is given also of the various experiments undertaken to pull out electrons by high voltage. Description is given of an experiment which is being carried in the laboratory for the testing of these theories.

78. A note on the Zero error of a sextant.

R. L. Bhargava, Allahabad.

The practical text books mention very little about the zero error of a sextant and as to how it should vary with the distance. It is found that when the zero error is plotted against the reciprocal of the distance of the object for which the zero error is found, we obtain a straight line as should be expected. From this graph, the distance between the index and horizon glasses is found and this is checked by directly measuring that distance.

79. A note on the logarithmic decrement and period of a damped ballistic galvanometer.

JAI CHANDRA *and* D. V. GOGATE, Allahabad.

It is well known that the logarithmic decrement of a ballistic galvanometer depends on the resistance in the external circuit. Elementary theory will indicate that the logarithmic decrement, when plotted against the inverse of the resistance in the circuit should give a straight line. An attempt has been made to verify the relation and it is found that this is true over a wide range of the logarithmic decrement.

The period of the galvanometer on closed circuit is larger than that on open circuit. The relation between the two periods can be easily obtained. The period on closed circuit is measured for various values of external resistances. The relation between the closed and open circuit periods is obtained and found to be correct.

80. On the Harmonics of a Tuning Fork.

N. PARAMESWARAN *and* T. S. SUBBARAYA, Mysore.

Contrary to the usually accepted view that a tuning fork has no overtones that are harmonics, it has been found that the octave certainly and the third also possibly are to be found accompanying the fundamental. Experiments have been made to ascertain how the harmonics are given out, particularly to test the correctness of a possible explanation based on a remark of Lord Rayleigh's. Experiments so far carried out show that this explanation does not cover all the facts. Other experiments to further test the same thing are in progress.

81. The vibrations of the Pianoforte sound-board.

L. D. MAHAJAN, Patiala.

The vibrations of the pianoforte sound board are recorded photographically. Electromagnetic devices are used for moving the photographic plate and pressing the key of the piano with a given force at the same time.

The curves thus obtained, are magnified on graph papers and then analysed by the mechanical method of H. O. Taylor. The amplitudes of the harmonics up to the 12th, in each case for different tones of the pianoforte, are found. The following results are concluded.

The fundamental of the middle tones is very high and less number of higher harmonics are present. Their amplitudes are small. The fall of intensity is very slow. The duration of sound is very long.

The fundamental of middle tones is very high and less number of higher harmonics are present. Their amplitudes are very high. The fall of intensity is rapid. The duration of sound is comparatively small.

The fundamental of the higher most tones is very high. Almost all higher harmonics are absent. Their amplitudes are very small. The fall of intensity is very rapid. The duration of sound is comparatively still smaller.

The curves showing the relation of the amplitudes of the harmonics of the various tones and their frequencies are drawn. The maxima of the curves are found to shift from the higher harmonics of the lower tones to the lower harmonics of the higher tones. The graphs clearly indicate the frequencies of resonance of the sound board. The string and the sound board evidently form a coupled system.

The study of the effect of the soft pedal on the vibrations of the sound board shows that the curves become smooth and decrease in amplitudes.

82. The Quantum Analysis of the Band Spectra of Magnesium Oxide.

P. C. MAHANTI *and* B. C. MUKHERJEE, Calcutta.

By using a new method of excitation, the bands of MgO have been obtained. Some new bands have also been measured. All these bands lie between the region 6000 to 4700. They form two definite systems—one system degrading towards the violet and the other towards the red. They thus indicate two electronic transitions. Each system consists nearly 50 bands. The isotopic effect of $Mg^{26}O$ has also been observed and calculated. Finally, the heat of dissociation of the molecules has been evaluated.

83. Infra-red Absorption Spectra of the Di-halogen derivatives of Methane.

P. C. MAHANTI, Calcutta.

The vibration-rotation spectra of C_2H_5Cl, C_2H_5Br, and C_2H_5I in the gaseous state have been studied. The apparatus used is nearly the same as used by Imes and others. A four-prism spectrometer with Wardsworth arrangement has been used to select radiation of a fairly large range of wave-length from the emission of a Nernst filament. A stainless steel concave mirror of 10 cms. diameter and 50 cms. focal length collimates the beam which is then incident on the grating. Two gratings have been used during the investigation—one ruled on gold with 960 lines per cm. and the other a chromium plated echelette grating with 814 lines per cm. A vacuum thermopile in conjunction with a Paschen galvanometer has been used as the detecting arrangement. The main absorption bands are found to shift towards higher wavelengths with increasing atomic weight of the halides in the polyatomic molecules.

84. On a new type of Sodium arc lamp and its Spectral Behaviour.

C. K. SUNDARACHAR, Bangalore.

A simple type of sodium vapour lamp of pyrex glass with a tungsten wire 1 mm. thick as anode is described. It is not necessary, as in the case of Lord Rayleigh's lamp, to have a burner underneath the lamp to prevent the condensation of the metal on the walls, and no inductance is used in the circuit to steady the arc. The lamp is easily constructed and works steadily with a current of 2 to 6 amperes, drawn from a battery of 120 volts. Using a quartz spectrograph and a current of 6 amperes, the higher members of the principal series of sodium have been traced up to $m=14$. Only nine lines of this series have been observed by Zickendraht and others. It is also noticed that the higher members become stronger relative to the lower members with increase of current in the arc. A 10-foot concave grating spectrogram is being taken to make a further study of the line and band spectra.

85. Thermal effects in the figuring of large optical surfaces.

H. Parameswaran, S. P. Venkateswaran, *and*
K. S. Venkatraman, Madras.

In continuation of the work reported last year the paper discusses the temperature effects observed during the figuring operations of a twelve inch spherical mirror as well as a twelve inch flat.

86. The Raman spectra of Paraffins and Olefinic Terpenes.

C. Ramaswami, Madras.

The Raman Spectra of Pentane, Hexane, Heptane, Geraniol, and Linalol, have been photographed by Wood's method. The Spectra have been analysed and the results of the Spectra are discussed.

87. Raman effect in regard to faint Fraunhofer lines and the fine structure of K-absorption.

D. S. Kothari, Allahabad.

It is possible that many of the un-identified faint Fraunhofer lines are due to the combined effect of ordinary absorption and Raman scattering from molecules like *CN* which are considered to be strongly present in the sun. Some calculations are made by taking the data for *CN* from band spectra. There is fair agreement between the wave lengths of the faint Fraunhofer lines calculated in this manner and those actually observed.

It is suggested that the fine structure accompanying the absorption edges in X-rays may be explained on similar lines.

88. Raman spectra in atmospheres surrounding Metallic Arcs.

B. Venkatesachar *and* L. Sibaiya, Bangalore.

The spectrum of the mercury arc in an atmosphere of carbon-dioxide at a pressure of 6 cms. of mercury contains two faint lines coinciding in position with the two Raman lines recorded by Rasetti (Nature, Feb. 9, 1929). Our spectrogram was taken in connection with a study of the spectrum of the mercury arc in atmospheres of foreign gases (Indian Jour. Phys., IV, 2, pp. 179–193, 1929):

Exciting line.		Raman line.		$d\nu$	Rasetti's value.
λ	ν	λ (Int.)	ν		
2536	39413	2622 (1)	38124	1289	1284 ± 10
		2628 (1)	38034	1379	1392 ± 10

That these faint lines are Raman lines of carbon-dioxide is supported by the fact that they disappear when carbon-dioxide is pumped out and do not re-appear on the introduction of hydrogen. Other bright ultra-violet lines also show the corresponding Raman lines, which, however, are fainter than the above. This observation suggests a method of producing the Raman spectra of gases by running the exciting arc in an atmosphere of the gas. An attempt to obtain the Raman lines of carbon-tetrachloride in the visible region by running a mercury arc in an atmosphere of carbon-tetrachloride vapour was inconclusive on account of the complex band spectra occurring in the region.

Our results with carbon-dioxide suggests a possible origin of at least some of the faint unclassified lines observed in all spectra. We have tested this hypothesis in the case of zinc and mercury using Coblentz and Geer's extreme infra-red emission frequencies of mercury and Zinc given in Kayser's Handbuch der spectroscopie, believing that they are molecular in origin. We find that in a considerable number of cases there are faint lines of intensity 1 or 2 corresponding to the calculated values. Moreover nearly all these lines are marked nebulous; as an instance may be mentioned the nebulous mercury line at 2687.

Exciting line.		Raman line.		$d\nu$	Observed infra-red frequency.
λ	ν	λ (Int.)	ν		
2536	39413	2686·67 (1)	37209	2204	2206

The above Raman line disappears when the arc is cooled, a fact easily explained as due to the reduction in the concentration of the scattering molecular centres. Allan (Nature Jan. 26, 1929) has given reasons for believing that certain faint lines in the secondary spectrum of hydrogen have a similar origin, the exciting radiation being the first few lines of the Balmer series. Kothari (Nature July 20, 1929) has adduced reasons for believing that the faint Fraunhofer lines are probably due to a similar phenomenon and subsequent absorption, in the chromosphere of the sun. Some of the faint lines of as yet unknown origin in the spectra of many celestial bodies might turn out to be Raman lines of this kind.

89. Shanti Swarup Sharma's Analogue of Wiedemann-Franz Law.

Satyendra Ray, Lucknow.

S. S. Sharma in autumn of 1926 drew the author's attention to the analogy between the thermoelectric relationship between the thermoelectric power and the specific heat of electricity and the similar relationship in thermodynamics between latent heat and specific heats. A theoretical explanation is given of this anologue.

90. A note on Zeeman Effect.

Satyendra Ray, Lucknow.

It is shown that the Zeeman Effect should give us a continuous *band* instead of isolated lines as obtained. It, therefore, appears the phenomenon may be other than what we take it for. (Copy sent to Prof. W. Gerlach.)

91. The Polarisation of Cells.

D. V. GOGATE *and* Y. G. NAIK, Lucknow.

Ahmadi and Tandon have proved the futility of employing A. C's in the determination of electrolytic resistances. This makes the study of "Polarisation" of paramount importance. Electric cells themselves furnish the best subject of study in this matter. The decay of E.M.F. with time to a limiting value, and the increase of internal resistance to a corresponding value seems to be indicated, log $(E_0-E)/E_0$ plotted against t does not give us a rectilinear graph.

92. The Polarisation of Electrolytes.

RAM SARAN *and* JAGDISH NARAIN SAKSENA, Lucknow.

With feeble currents the polarisation of electrolytes was studied by taking the variation of resistance with time. It was found that the resistance rose to a steady limiting value from 12 minutes to an hour.

93. An electrical Liesegang Phenomenon.

A. C. BANERJI *and* H. S. JAIN, Lucknow.

A wire-like formation formed by the passage of an arc between two hard steel electrodes showed on examination a striated structure. It is believed it is a Liesegang Phenomenon of the type indicated by Ray in Koll Zeit, XLIV, 277, 1928.

94. High Frequency discharge through gases—Hydrogen.

B. S. SRIKANTAN, Bangalore.

A 2–10 meter oscillator has been constructed to study the effect of electrodeless discharge on gaseous reactions. As a preliminary step, the effect of the discharge through hydrogen in ordinary and pyrex glass vessels has been examined. Ordinary glass does not yield concordant results. In a baked out pyrex tube as soon as the discharge is started, the hydrogen is rapidly absorbed by the walls of the vessel but in course of time the gas is slowly given out again, until a steady state is reached. The absorbed gas may also be liberated by heating the tube. The mechanism of this phenomenon is being investigated.

95. The turning couple on a cylinder in a stream of viscous liquid.

N. R. SEN, Calcutta.

It is well known that the "lift" in aerodynamics or the transverse force on an infinite cylindrical body moving uniformly in a perfect liquid can be explained by assuming a circulation round the body. This cannot, however, account for the "drag" or head resistance for which other characteristics of the motion such as the formation of the "vertex street" in Karman's theory or circulation in the theory of Riabouschinsky, have to be considered. Recently Filon has been able to obtain both the lift and the drag for a *viscous* liquid by assuming the motion to be periodic in course of which vortices separate from the surface of the cylinder (supposed to be at rest in a uniform stream of viscous liquid) and flow down the stream in its rear. The viscosity of the liquid again produces a dissolution of the vortices which all disappear before they cross a circle of sufficiently large radius. On this circle and outside only the potential motion exists. Filon has derived from these assumptions both the lift and the drag. In the present paper by an application of the principle of angular momentum to the liquid inside the circle the couple on the cylinder has been calculated. Three constants appear in the expression for the couple one of which determines the circulation and the other two for which physical interpretations are given, come from the integrals of the equations of motion. If L_B be the moment of the buoyancy, Γ the circulation, U the viscosity of the stream, μ the viscosity constant, s the density of the liquid, l a certain linear dimension of the body and $R=\frac{Uls}{\mu}$, the Reynold's number characteristic of the motion. the moment L is given by

$$\frac{L-L_B}{2\mu\Gamma}=-1+\frac{8\pi l}{\Gamma R}\left[A_1-\frac{l}{R}(A_0+3a_2)\right]$$

This form suggests that the constants must be expressible as

$$A_1=\frac{\Gamma R}{8\pi l}f_1(R), \qquad A_0+3a_2=\frac{\Gamma R^2}{8\pi l^2}f_2(R)$$

96. Satellite Absorption and Fine Structure Levels for Prominent Mercury Lines.

B. VENKATESACHAR *and* L. SIBAIYA, Bangalore.

Ruark has accounted for the emission of several of the satellites of mercury lines by splitting the initial and final levels corresponding to the radiation of a complex line into close sub-levels with small wave-number differences. It is possible to suggest alternative schemes for the fine structure levels and there is, at present, no means of knowing which scheme represents facts. Making use of the observation that each of the lines 5461 ($2^3P_2-2^3S_1$) and 4047 ($2^3P_0-2^3S_1$) contains an unabsorbed satellite and assuming that they correspond to transitions from the same initial fine structure level of 2^3S_1, we have worked out a scheme of sub-levels which accounts for the satellites of a number of complex line

97. The Numerical Solution of partial Differential equations.

GORAKH PRASAD, Allahabad.

Methods of solving ordinary differential equations numerically have long been known and have now found their way into text books. A method of solving Integral equations was given by the author sometime ago (Proc. Edinburgh Math. Soc., Vol. XLII, pp. 46–59, where further references to the subject will be found). But it appears that up till now no method for solving partial differential equations numerically has been published. The present paper gives for such equations a method, which is very accurate, fairly rapid, and pretty general.

Starting with the differential equation in which s is given by a known function of x, y, z, it is shown how a solution can be obtained step by step. A particular case is worked out which shows that the value of z to six places of decimals can be easily found for a large region in the x, y plane. Next it is shown that the differential equation in which s is given by a known function of x, y, z, p, q, can also be found solved by a similar method. Finally it is shown how equations of other types can be transformed to the forms considered above.

98. On the connection between the functions of Bessel and Weber-Hermite.

R. S. VARMA, Allahabad.

The Hermite polynomial is intimately connected with the harmonic functions associated with the parabolic cylinder functions which can be expressed in terms of a particular form of the generalized hypergometric function and it has also been shown that Bessel functions can be expressed in terms of a (different) particular form of this function. In the course of obtaining some integrals involving Weber-Hermite and Bessel functions, the present author has also, in his paper "on the parabolic cylinder functions "(Proc. Benares. Math. Sec., Vol. IX, 1927) obtained a series connecting the Weber-Hermite and Bessel functions. The present paper is a further attempt to connect the two functions and thus study same properties of the Weber-Hermite functions.

The author has obtained first a general result connecting the two functions and a particular case of it is then expressed in terms of a definite integral and its properties, recurrence formulæ, etc., are deduced. The series of Weber-Hermite functions obtained by the author in his paper referred to is also given in the form of a definite integral and similar properties investigated. Finally the author has expressed Bessel function of order n in terms of a series of parabolic cylinder functions.

99. Variation of Extinction Co-efficient with temperature.

N. R. TAWDE, Bombay.

Bhattacharji, Mukerjee, and Dhar have found with some coloured solutions a widening of absorption band with rise in temperature of the solutions. The extinction co efficients determined by them were found to vary with rise in temperature. (J. Phy. Chem., xxxii, 1,834). The writer has further extended investigations in this direction on some more coloured solutions and found that the extinction co-efficients increase appreciably with rise in temperature, though the exact relation between them has not yet been verified.

100. Analogues of Abel's Theorem for degenerate and singular cubics.

A. A. KRISHNASWAMY IYENGAR, Mysore.

It is well known that Abel's Theorem for the non-singular cubic is very useful in the demonstration of geometrical properties of the cubic. This paper shows that by a suitable choice of parameters a similar theorem can be proved for all kinds of cubics-degenerate nodal or cuspidal—and so, all the properties of the non-singular cubic which can be proved by Abel's theorem have their analogues for other cubics as well. Several well-known theorems such as those due to Menelaus, Carnot, Pascal, and Desargues are seen to be direct manifestations of the central principle $\Sigma Ur=O$ common to all cubics.

101. The Seventeen Points Cubic.

M. BHEEMASENA RAO, Bangalore.

It is known that if a conic touches the sides of a triangle at points where the normals are concurrent, the point of concurrence of the normals lies on a non-singular cubic which passes through the vertices of the triangle, the circum-centre, ortho-centre, in-centre, ex-centres, points at infinity on the altitudes, points diametrically opposite to the vertices on the circum-circle, the ortho-centre of the anti-medial triangle and its isogonal conjugate with respect to the triangle of reference. The properties of this cubic are very interesting, for example, the important property that the pedal circles of points on the cubic can be arranged in groups of pairs of tetrads such that each circle of one tetrad touches all the circles of the complementary tetrad, already published by me in Vol. 13 of the Journal of the Indian Mathematical Society, pages 109–116.

This cubic is capable of treatment by methods of Pure Geometry and the following are some of the properties discussed in this paper:—

(1) The line joining any point on the cubic and its isogonal conjugate passes through the ortho-centre of the anti-medial triangle.

(2) The line joining the centre of the conic referred to above and its isogonal conjugate passes through the median point of the triangle of reference.

(3) The Pedal circle of any point on the cubic cuts the nine point circle on a tangent to the Steiner ellipse of the medial triangle.

(4) The mean centre of the points of contact of tangents to the cubic from any point thereon is the circum-centre of the triangle.

(5) The cubic can be generated in three ways by means of three coaxal systems of circles determined by a side of the medial triangle and the circle described on the corresponding side of the triangle of reference as diameter.

(6) Let P, P' be isogonal conjugate points of the cubic, DEF the pedal triangle of P, and LMN the mid-points of AP', BP', CP', (ABC is the triangle of reference). The circles described on DL, EM, FN, as diametres pass through a point of intersection of the pedal circle and the nine point circle.

(7) The cubic has a centre, viz., the circum-centre of the triangle. Let DEF, $D'E'F'$, be the pedal triangles of diametrically opposite points on the cubic. The common orthogonal circle of the circles described on DD', EE', FF', as diameters which are easily seen to touch the nine point circle, belongs to a special class of circles cutting the sides of the triangle in points forming two triangles in perspective with the given triangle (extension of theorem kindly communicated to me by Mr. V. Ramaswami Iyer, President of the Indian Mathematical Society).

Constructions for finding the points of intersection of the cubic and (1) any line through a vertex of the triangle, (2) any line at right angles to a side of the triangle, (3) for drawing the tangent at a given point are given in the paper.

102. Statistical Analysis of the Medical Inspection of Students of the Sir Minakshi College and the Annamalai University.

G. V. KRSHNASWAMI, Chidambaram.

103. Atmospheric Ozone and Solar Cut-off.

A. L. NARAYAN *and* MD. SALARUDDIN, Kodaikanal.

The recent investigations of Dobson show that the lowest Ozone values are found in the tropical regions and that there is very little annual variation in the amount of Ozone in these regions. It is well known that the Ultra-violet limit of the Solar spectrum is due to absorption by Ozone present in the upper atmosphere. Using a photographic photometer, Fabry and Buisson found that this Ozone layer behaves as if it were metallic in character, for light of wave-length 2,550 A.U. The path of the

Sun's radiation through the Ozone layer will be shorter the higher the Sun. To get strong Ultraviolet radiation it is necessary to have both sec. Z and ozone as small as possible. It, therefore, appeared from these above investigations of Dobson, that the ultraviolet cut-off due to ozone, may be less powerful at a tropical station like Kodaikanal (lat. 10° 14′). With the kind permission of Dr. Dobson a number of photographs have been taken here, using his Fery spectrograph, when the altitude of the Sun is high The few best photographs that were obtained between 11·30 and 12 30 showed that the spectrum extends to about 2820 A.U. at the Ultraviolet end. The photographs also show that between 2880 A and 2830 A, there are not probably bands of any great intensity. It seems to be one of general absorption and if fine bands exist they are inconspicuous. At about 2823 A, there is a strong absorption band of more than the average breadth. It may be mentioned in this connection that in England Dobson got spectra extending to 2930 A, while Fabry and Buisson got spectra extending to 2912 A, at Marseilles (lat. 43° N). These photographs seem to lend further support to Dobson's recent suggestion that to get spectra extending as far as possible into the ultraviolet, astronomers should go to tropics.

104. A note on the Eruptive Prominence of September 5.

A. L. NARAYAN, Kodaikanal.

A series of photographs of a large eruptive prominence was obtained at Kodaikanal, using the Cambridge Spectroheliograph. This prominence extended in latitude from--15° to 47° and reached a maximum height of 13.5′ (5,60,000 K.m). It seems to be one of a very enduring type. First it was observed as a massive prominence in latitude from—11° to 32° E from the 25th to the 27th of August. Then it developed into a conspicuous absorption marking in $H\alpha$ spectroheliograms. This absorption marking could be photographed in $H\alpha$ for 8 days. On the morning of September 5, the entire length of the dark marking was dissipated by the eruption. It would appear from this that prominences giving strong absorption markings in $H\alpha$ are most unstable and are likely to end in eruption. Visual observations in the grating spectrograph attached to the 6′ equatorial showed that the greatest displacement observed was about 5.5 A.U. to the red at A.M. The displaced portion of the line was completely detached from the undisplaced line.

105. Further regularities in the Spectrum of *As* III.

A. S. RAO *and* A. L. NARAYAN, Kodaikanal.

In a recent paper (Ind. J. Phy., Vol. 111, p. 111, pp. 438) it was shown that many of the important lines belonging to doubly ionised *As* could be arranged into a series of regular doublets resulting from transitions of the outermost 'p' electron. It was found from the spectra of the element obtained under different conditions of excitation, that a number of lines that could be attributed with certainty to *As* III, remained unclassified. Attempts have therefore been made to find further regularities and many of the unclassified lines have entered into Quartet systems. the terms identified being:

$5s'{}^4P$; $5P'$ (${}^4P$, ${}^4S$, and ${}^4D$) and $5d'$ (${}^4D$ and ${}^4F$).

And it is found that

	$5s'$, ${}^4P$	separations	are	2133	and	1062		
	$5p'$, ${}^4P$	,,	,,	1324	,,	737		
	${}^4D$	,,	,,	1429	,,	793	and	432
	$5d'$, ${}^4D$	,,	,,	1283	,,	749	,,	367
and	${}^4F$	,,	,,	850	,,	367	,,	124.

106. On the Second Spark Spectrum of Lead.

A. L. Narayan, *and* A. S. Rao, Kodaikanal.

The second spark spectrum of Lead was recently analysed by K. R. Rao and the writers of this note: and a preliminary report of the series regularities discovered was published in a paper (Ind. J. Phy., Vol. 2, p. 4 pp. 468–476).

The writers have since become aware of similar publication by Smith. (Proc. N.A.S., Vol. 14, 1928, pp. 878–880). There is a good agreement between our results and those of Smith, except in the identification of 1^3P-1^3S. Evidently he has our 1^3S_1 as his $1^3\bar{P}_1$. Caroll has very irregular intensities for the lines suggested by him. The 1^3S_1 suggested by the writers is supported by the location of the second series 1^3S-2^3P, 1^3D-2^3P and 2^3P-2^3S. Furthermore, 1^3P-1^3S suggested by us is given additional support by the closeness with which it follows the irregular doublet law, for the isoelectronic sequences *Hq* I, *Tl.* II, and *Pb* III. An interchange of his levels 1^3S_1 and $1^3\bar{P}_1$ would probably bring the whole scheme into alignment with ours. As a result of our attempts, to get further regularities, we have been able to get 2^3P-2^3D, and 2^3P-2^3P as well.

At the time of publication of the above paper not much progress was made in the identification of the singlet spectrum. Attempts have since been made to identify this and all the important lines arising from combinations between the singlet terms and intercombinations between singlet and triplet terms have also been identified.

Kodaikanal Observatory.

107. On the Series Spectra of *In* III and *Sn* IV.

A. S. Rao *and* A. L. Narayan, Kodaikanal.

The second spark spectrum of Indium and the third spark spectrum of *Sn* were investigated for series relationships and the principal members of the doublet series were indicated in a previous paper. Lang reinvestigated the spectra by obtaining photographs of the elements, with a Vacuum grating spectrograph. Though there was general agreement between our results and those of Lang, there was an important difference in the identification of 1^2D-1^2F, in *Sn* IV. The spark spectrum of tin was consequently photographed again in the region 2000–2100 A.U. and it was suggested that the large *F* term obtained by Lang and the smaller term found by us might be supposed to form a Rydberg sequence. By adopting this interpretation a complete system of terms was calculated, through a series of interrelated pairs. Similarly from a co-ordination of our results with those of Lang on *In* III, a complete system of energy levels was calculated, which has enabled us to predict and identify 1^2D-2^2P.

108. New Bands in the Spectrum of Hydrogen part III.

D. B. Deodhar, Lucknow.

A system of seven new bands in the Hydrogen Spectrum has been discovered in the violet region of the Spectrum. These bands are very similar in their nature to those published as Part I and Part II. They are separated from each other by about 150 wave numbers and their lines are picked from an intensity chart taken on Moll's selfregistering photometer. It appears that the sets in Part I, II and III have got different initial levels and that they all possess one common final level. The moment of intertia of the molecule worked out in this case is of the order of $5 \times 10^{-41}\ gm.\ cm^2$, and the usual combination principal is found to obey throughout. These bands are due to an excited H_2 molecule.

109. A New Band in the spectrum of Oxygen.

D. B. DEODHAR *and* S. K. DUTT, Lucknow.

A new type of discharge tube was prepared and after evacuation to about $10^{-3}mm.$ of *Hg*, it was filled with oxygen prepared by heating chemically pure potassium permanganate in a vessel with a side tube attached to the system. The oxygen so prepared was made to pass over $NaOH$ and P_2O_5 before entering the discharge tube. The tube was excited by the usual induction coil and the spectrum photographed by the large Interchangeable Hilger spectrograph of 10′ focus which gave a good dispersion in the visible region. The pressure of the oxygen was about $3mm.$ of *Hg*. In addition to the bands in the red and the yellow a distinct band head repeatedly appeared at 4528 *A*°. Some of the lines in this band are arranged in related groups and further work is in progress.

110. Scattering of X-rays in liquids at high temperatures and in solutions with special reference to the theory of Raman and Ramanathan.

V. I. VAIDYANATHAN.

The liquids examined had generally two haloes. The increase in the diffuseness of the inner haloes was more striking at very high temperatures than those of the primary haloes. In benzene and cyclohexene the various effects were remarkably prominent at 210°*C*.

In the case of associated liquids like phenol, propionic acid, caproic acid, etc., the intesities of the inner haloes were not found to diminish to any marked extent when they were maintained at moderately high temperatures. These temperatures were not high enough for the thermodynamical effects to set in to any appreciable extent. The absence of such an effect on the inner haloes is taken to mean that their origin is not purely due to the associated molecules, but depend on the corresponding state of the liquid, the form of the molecule and the electrical polarity.

In the case of ethyl ortho phthalate, nitrobenaldehyde and tetranitromethane; heated to 235°, 165° and 120°*C* the thermal effects were comparatively small and this was specially the case with the outer maxima which are slightly fainter than the primary haloes.

111. Properties and applications of bi-metallic strips.

J. K. CATTERSON-SMITH.

Experiments demonstrating properties. Production of very thin strips. Increased sensitiveness. Application to various types of physical apparatus. Hot-strip ammeters. High-frequency instruments. Heat motors. Co-efficient of emissivity of thin strips and helices.

112. Measurements at high voltages.

G. YOGANANDAM.

A simple method of measuring accurately the voltage, Current, and Power-factor of high voltage circuits is described, in which, a special apparatus constructed in the Laboratory at the Indian Institute of Science is made use of. The possibility of utilising the same apparatus with the aid of valve amplifiers, for the operation of relays, switch board instruments, and synchronoscopes, is suggested.

113. Dielectric losses in transformer oils.

S. K. Roy, G. Yoganandam *and* T. J. Mirchandani.

An experimental study of the losses in transformer oils is made with the help of the high voltage Schering bridge. The effect of voltage and temperature on the losses and power factor is shown by the aid of graphs. An attempt is made to explain the results obtained.

114. Effects of Parallel Electric and Magnetic fields on the Energy Levels of *H*–type Atoms.

D. P. Ray-Chaudhuri.

The problem is considered from the standpoint of wavemechanics and worked out for the H_α levels (n=1.2.). Two cases are considered, first, where the effects due to the electric field (F) and magnetic field (H) are large compared with the relativity effect; secondly, where the latter is large compared with the first two. In case (1) each level (n=1 or 2) is broken up into a number of new levels whose separations from the original level contain simple multiples of $\pm\omega$ and $\pm G$, in addition to the relativity separation term proportional to μ. ($G=(n+1)\Delta$, Δ and ω are units of Stark and Zeeman effects respectively.) In case (2), simple integral co-efficients of ω and G in general do not occur. For any value of n, $2n$ of the levels contain a term proportional to G^2, while the others except the two uppermost ones contain G. In both (1) and (2), there is a pair of levels same for both strong and weak fields whose separations increase linearly with H, and are independent of F. The mutual interaction between H and F is more complicated in (2) than in (1). These properties are shown in the following scheme of level separations (n=1 only); to avoid complications only the first order terms are given for the weak fields.

The transitions obey a selection principle in which a number m changes by ± 1 or 0 corresponding to $\perp r$, $\perp l$, or $\parallel$ polarisation.

$n=1$.

(i) G and $\omega >> \mu$

$$\Delta W = -\frac{11}{24}\mu \text{ (double root)};\ -\frac{11}{24}\mu \pm \omega \pm G;\ -\frac{\mu}{8} \pm 2\omega.$$

(ii) G and $\omega << \mu$

$$\Delta W = -\frac{\mu}{8} \pm 2\omega;\ -\frac{\mu}{8} \pm \frac{2}{3}\omega + \frac{4}{3}\frac{G^2}{\mu};\ -\frac{5}{8}\mu \pm \frac{\omega}{3} \pm \frac{G}{V_3};\ -\frac{5}{8}\mu \pm \omega \pm \frac{G}{V_3}.$$

115. On some problems in Nuclear Physics.

M. N. Saha, Allahabad.

Nuclear Physics may be defined as that branch of Physics which deals with the formation of atomic nucleii out of protons and electrons. Recently problems in this branch are accumulating, *e.g.*, variation of mass of elements from the whole number law, formation of neutrons with loss of mass of amount ($M\alpha$, α=Sommerfeld's constant), origin of cosmic rays and γ-rays, and deviation of the law of force from the inverse square law in the vicinity of the atomic nucleus.

These problems are described and different ways of finding out their solution from Schrodingar's wave mechanics and Dirac's modification of Schrodinger mechanics are described.

116. On a new Fluorite Spectrograph.

M. N. Saha, Allahabad.

A new Fluorite Spectrograph has been constructed in the workshop of the Physical laboratory. The apparatus is very light—strong, and can be easily taken to pieces. Photographs taken with the spectrograph are described.

117. On the geometrical aspect of the concomitant system of *n* linear complexes associated with a quaternary quadric.

P. N. Das-Gupta.

In his thesis (sent for publication) the writer has discussed the invariant theory of a quaternary quadric associated with *n* linear complexes. When $n=2$, the geometry was discussed in the thesis, as also an irreducible system indicated there for *n* linear complexes and a quaternary quadric. In the present paper it is shown that two of the typical invariants gives conditions of the Quadric of three linear complexes being in-polar and out-polar with reference to the quadric and another invariant gives the condition that the linear complex apolar to a set of five linear complexes is apolar to the sixth complex. There are two types of covariant quadrics which are such that one type is transformed into another when polar linear complex is substituted for an ordinary linear complex and the two types are polar reciprocals for the given quadric. A covariant and a contravariant form, listed as irreducible, are now found reducible.

118. On the fine structure of the Energy Levels of Cadmium and Thallium.

S. B. L. Mathur, Bombay.

A study of the fine structure of spectrum lines initiated by Michelson, Janicki and others has received an additional importance of late owing to the insight it gives into the structure of the atom. Nagaoka, Suguira and Mishima suggested that the fine structure of the lines may be due to isotopes. Since then, other theories have been put forward. Ruark and Chenault believed that slight quantized variations in the configuration of loosely bound underlying electron shells sufficed to explain the phenomenon, while Goudsmit and Back and also Jackson suggest that the cause lies deeper and may be due to a quantised spin of the Nucleus.

In view of the immense importance of the subject, the author in collaboration with Dr. Wali Mohammad undertook an extensive investigation and two of his studies, viz., those on Cadmium and on Thallium have been published in the July 1927 and May 1928 issues of Philosophical Magazine. The work under report is the theoretical counterpart of the papers already published and attempts to deduce the fine structure of the Energy Levels of the two elements from a consideration of the data previously obtained.

119. Thermal conditions in Free Atmosphere over North-west India.

G. Chatterjee, *and* N. K. Sur, Agra.

On the basis of data obtained from the records of meteorographs, sent up at Agra with sounding balloons of special type within the period July 1925–March 1929, changes of temperature up to a height of 20 kilometres and of humidity up to 10 kms. have been described. Figures showing the mean height-temperature curves and prevailing wind directions in summer, monsoon, post-monsoon, and winter seasons have been drawn and their characteristic features discussed.

The change from the equatorial type of tropopause, characterised by low temperature and sharp inversion to a more or less isothermal condition of the temperate regions with a comparatively higher temperature has also been discussed.

120. Upper winds at Agra.

N. K. Sur, Agra.

General features of the upper winds at Agra up to a height of 18 kilometres in the monsoon season from July to October and in the months of November–June have been described. These features have been compared with those of Europe and Batavia.

121. Optical anisotropy of the fatty acid molecules.

S. Bhagavantam, Calcutta.

The paper describes the behaviour of thin films of some of the higher members of the fatty acid series and certain unsaturated ones, namely, lauric acid, palmitic acid, stearic acid, isoerucic acid, brassidic acid and behenic acid under a polarising microscope. The feeble birefringence exhibited by the crystalline film in each case is measured with a Berek compensator. A comparison of the data with the values of optical anisotropy of the earlier members—formic acid, acetic acid, etc.—as revealed from the studies on light scattering, shows that the anisotropy falls off very rapidly with increasing number of carbon atoms in the molecule

122. Raman effect in halogen compounds.

S. Bhagavantam *and* S. Venkateswaran, Calcutta.

The Raman effect in the following halogen compounds has been studied. Chloroform, bromoform, carbon tetrachloride, methylene chloride, ethyl bromide, ethylene chloride, ethylene bromide, propyl chloride, propyl bromide, isopropyl chloride, isobutyl chloride, isobutyl bromide, allyl chloride, allyl bromide, hexachloroethane dissolved in carbon tetrachloride, para dichlorobenzene dissolved in carbon tetrachloride, chlorobenzene, bromobenzene, benzal chloride, and benzyl chloride. The results are discussed with special reference to the substitution of the heavier bromine atoms.

123. Raman effect in some aldehydes.

S. Bhagavantam *and* S. Venkateswaran, Calcutta.

The following aldehydes have been studied and their Raman spectra analysed. Acetaldehyde, paraldehyde, anisaldehyde, cinnamonaldehyde, salicylaldehyde, benzaldehyde, capric aldehyde, undecylic aldehyde, and lauric aldehyde. Paraldehyde, a polymer of acetaldehyde, shows a prominent continuous spectrum in addition to the Raman lines. As we proceed up the series the sharp Raman lines become diffuse and the continuous spectrum becomes more prominent.

124. Raman spectra in optical isomers.

S. BHAGAVANTAM *and* S. VENKATESWARAN, Calcutta.

The Raman spectra of *d* and *l* rotatory pinenes are compared. Although the spectra resemble closely, certain interesting differences are noticed.

125. Raman effect in isomeric compounds.

S. BHAGAVANTAM *and* S. VENKATESWARAN, Calcutta.

The influence of isomerism in organic compounds on Raman scattering as evidenced in butyl alcohol and two of its isomers, namely, isobutyl alcohol, and trimethyl carbinol is discussed.

126. Raman effect in amorphous solids.

S. BHAGAVANTAM *and* S. VENKATESWARAN, Calcutta.

Two typical organic substances namely, salol and betol have been studied in the molten and amorphous states and the Raman spectra compared.

127. The Second Spark Spectrum of Krypton.

D. P. ACHARYA, Patna.

L. Bloch, E. Bloch and Dejardin published a number of lines due to Krypton, their measurement extending up to λ 2227 Å on the ultra-violet side. In the present paper, many more lines have been measured and the observational data have been extended up to λ 1930 Å.

A partial classification of these lines, has also been attempted. Theoretical terms due to different electronic configurations, are given; and the positions of the lines due to various transitions are discussed. The quintets have been found, and regularities observed in other lines, definitely prove the existence of triplets, although the identification of terms, has not yet been possible. At the end is given a list of all lines thus classified and also of all new lines measured by the present writer.

128. Rotating Electron in a beam of light.

B. M. SEN, Calcutta.

The theory of Compton effect was investigated by Dirac using the methods of Heisenberg's Matrix Mechanics (Proc. Roy. Soc. 111, p. 405) and by Gordon with Wave Mechanics with frequent reference to the Light Quantum hypothesis and the Correspondence Principle. (ZS. f. Phys. 40. p. 117.)

In the present paper a solution of the Wave equation of Dirac's rotating electron under a plane polarised beam of light has been obtained. Dirac's equation is

$$[(p_0+e^1 V)+\alpha_1(p_1+e^1 A_1)+\alpha_2(p_2+e^1 A_2)+\alpha_3(p_3+e^1 A_3)+\alpha_4 mc]\psi=0$$

where
$$e^1=e/c,\ p_0=-\frac{h}{2\pi i}\frac{\partial}{c\partial t},\ p_1=\frac{h}{2\pi i}\frac{\partial}{\partial x},$$
$$p_2=\frac{h}{2\pi i}\frac{\partial}{\partial y},\ p_3=\frac{h}{2\pi i}\frac{\partial}{\partial z}.$$

V is the scalar potential and (A_1, A_2, A_3) the vector potential. We take

$$V=0,\ A_1=A_3=0,\ A_2=a\cos\omega(t-x/c).$$

Taking Dirac's value for the four-rowed matrices $a_1a_2a_3a_4$ we get four linear differential equations of the second order. Assuming a solution of the form

$$e^{\frac{2\pi i}{h}(k_1x+k_2y+k_3z+\lambda ct)}(1+B\sin\theta+c\cos\theta)$$

we get $$j_1:j_2:j_3=2k_1-\frac{2k_2e^1a\cos\theta}{\lambda+k_1}:2k_2+2e^1a\cos\theta:2k_3.$$

where $\theta=\omega(t-x/c)$, (j_1, j_2, j_3) being the stream vector.

There is thus an impulse not only in the direction of the ray as in Light Quantum hypothesis, but also in the direction of the Electrical force but none in the direction of the Magnetic force.

129. On the Absorption Spectra of Bromine.

S. Datta *and* Sachi Bhusan Datta, Calcutta.

The band absorption Spectra of Bromine has been studied with a 15 ft. Grating and its Gross-structure analysed. From the results of analysis the Dissociation Potential has been calculated. Observations have also been made regarding the development of continuous absorption for which an explanation is suggested.

130. On the spectrum of doubly ionised Bromine.

S. C. Deb, Allahabad.

(Communicated by Mr. D. S. Kothari.)

The spectrum of doubly ionised bromine is studied on the standpoint of Hund's theory and the transitions $[O_2-O_1]$, $[O_2-P_1]$ and $[O_2-O_3]$ are located and found out. A comparison of the analysis is made with similar analysis of spectra of F++ and Cl++ and a very good agreement is shown to exist between them.

Red and infra-red part of the spectrum are photographed and nearly all the lines of the transition $[N_3-O_2]$ are classified.

131. Regularities in the spectra of trebly ionised chlorine.

S. C. Deb, Allahabad.

Chlorine spectrum in the trebly-ionised state is analysed by Bowen in the Schumann region for the transition $[M_1-N_2]$. $[N_1-N_2]$ transition of the spectrum is found to situate in the region near about $\nu=35000$. The whole term system is analysed and is given in a tabular form; and with the help of Bowen's analysis absolute values of each terms are also obtained.

132. Spectrum of Bromine in its trebly ionised state.

S. C. Deb, Allahabad.

Spectrum of Bromine in its trebly ionised state arises from transition between a set of Triplet and singlet terms. The (O_1-O_2) transition of the spectrum is found to exist near about $\nu=38000$. All the lines arising from the transition are found out. A comparison is made between the similar transitions of F+++ and Cl+++.

As the difference between the terms ${}^3P_2$ and ${}^1P_1$ of O_1 in Br+++ spectrum is of the same order in that between ${}^2P_1$ and ${}^2P_2$ terms of BrV spectrum, some of the BrV lines are also found out and classified.

133. Extension of the Horizontal law of the elements of higher atomic numbers.

S. C. Deb, Allahabad.

Saha and Majumdar showed in a paper to Ind. Jour. Phy. (Vol. III, 1928) that if a series of seven consecutive elements having an element of 3rd group as its first member, is taken, then the spectra of each individual member of the series for similar transition follow an arithmetical progression law among themselves. This law is shown to exist also among the spectra of elements for the series of elements *Ga, Ge, As, Se, Br, Kr* and *Rb.* in their normal as well as ionised states.

134. A Dynamical Method for the determination of Young's Modulus by bending.

K. Prosad, Patna.

Using equation $\gamma=\frac{k\,.\,b}{2\pi l^2}\cdot m^2$

as given by the late Lord Rayleigh (Sound, 2nd. Ed. Vol. 1, p. 273), a method of considerable accuracy has been worked out for the determination of values of Young's Moduli of materials maintained electrically vibrating. Experiments have been made on steel, brass and glass by this method and the values obtained are in excellent agreement with those by the Static Flexure method on the same bars. Full details of the paper are to be found in Phil. Mag. Vol. 8, p. 548, March, 1929.

The possibility of this method in reconciling the discrepancy between the observed and calculated speed of transmission of Earthquake waves has been pointed out to the author by Prof. Daly of the Harvard University and some experiments made on marble bars have yielded very interesting results.

Further experiments are in progress.

135. A Vacuum Arc Lamp of new design for Spectroscopic work.

K. Prosad, Patna.

The paper (Jour. Sc. Inst., Vol. 6, No. 4, April, 1929.) describes a Vacuum Arc lamp of new design which differs mainly from the types hitherto employed in that by a suitable electromagnetic device, the arc can be struck in vacuum from outside as often as desired and can be run without attention for about an hour or so at a stretch, while the vacuum seal is so simply made, that even if the arc is to be uncovered, the time taken in resealing the cover air-tight is very short. Ordinarily, the arc works quite satisfactorily at a pressure of about 1 cm. of mercury, but if desired the vacuum can be further lowered. At the same time the mechanical parts are so simple that there is no possibility of anything going out of order. Photographs of some copper arc lines using Fabry and Perot's Interferometer revealed sharply their fine structure when the arc was used.

136. The value of $e\ m$ for thermions from an ampere-gauss characteristic of a hard diode valve.

K. Prosad *and* L. M. Chatterjee, Patna.

If a magnetic field is applied parallel to the filament of a diode valve and its strength gradually increased, then for a given plate voltage, the emission current remains constant until a certain value of the field when the current suddenly drops. It has been shown by A. W. Hull and others that at this point the following relation holds—

$$e/m=\frac{8\,.\,V}{H^2\,.\,R^2}$$

where e/m is the sp. charge of the thermions constituting the emission current, V the plate voltage, H the magnetic cut-off field and R the radius of the anode cylinder.

In order that the equation may apply to any actual valve, it must satisfy the following conditions:—

(*a*) The filament must be shorter than the length of the anode cylinder.
(*b*) The filament must wholly lie along the axis of the anode cylinder.
(*c*) The anode must be a geometrically perfect circular cylinder.

In actual practice it is extremely difficult if not impossible to satisfy all the above conditions in a valve and failure to comply with these, results in the ampere-gauss characteristic becoming much less steep than is theoretically indicated. The current drops at first abruptly, but later on there is a gradual rounding off of the curve as the mag. field is further increased with the result that the correct value of e/m for electrons is only obtained by taking the value of H not on the steep portion of the curve, nor that corresponding to the initial drop, but on the other hand by choosing H quite far from it and lying on the second gradual bend at the foot of the curve.

The paper discusses fully the various points raised and suggests a method whereby very good values for e/m for electrons, can be obtained even with valves most imperfectly made.

Experiments made by us have yielded very concordant results with different plate voltages and heating currents, the mean of which gave as the value of e/m for electrons$=1{\cdot}793\times10^7$ *E.M.U.*

137. An Electrical Method of determining some of the Elastic Moduli of conducting materials.

K. Prosad *and* S. K. Basu, Patna.

While studying the variation of Electrical Conductivity of metals under the action of γ rays from radium at reduced pressures, our attention was drawn to certain effects which could be satisfactorily explained on the assumption that the atmospheric pressure acting on the cross-sections at the ends of the wire under experiment in partial vacuum, produced compression. The following relation from which the Poisson's ratio σ can be calculated was worked out, namely

$$\sigma=\frac{\left\{1-\sqrt{\frac{R_p(E-2P)}{E{\cdot}R_o}}\right\}.E.}{2P}$$

Where P is the change in pressure in dynes/cm.^{2}, R_p and R_o are the resistances at the higher and the lower pressures and E is the Young's Modulus for the material.

In the same notation, if the resistance of the wire is measured when it is wholly inside the partial vacuum, as can be done with slight modification in making connection, it is also possible to calculate the Bulk Modulus k from the expression given below, namely

$$k=\frac{P.}{1-\frac{R_o}{R_p}\left(\frac{E-2P}{E}\right)^2}$$

Experiments so far made with lead have yielded fairly satisfactory results. It is hoped to extend the method to other materials also.

138. On the surface absorption of solutions of soaps and of inorganic salts in water.

G. SUBRAHMANIAM.

In the common method for the determination of surface tension of liquids by the "Capillary ascent" an accurate knowledge of the density of the liquid is as important as the height of ascent of the liquid. A method where such a capillary rise is neutralised by excess of pressure until the vertex of the meniscus is just in the same horizontal plane as the free surface has the two following advantages:—

(1) A knowledge of the density of the liquid becomes of secondary importance as it affects only the *correction* term,

(2) it is capable of indicating changes in the behaviour of the surface film.

By applying this method to a study of the relation between the superficial tension and concentration of soaps in solution, it is found that the surface tension of a freshly formed surface decreases with increasing concentration until it attains a minimum value. When, however, the surface is allowed to stand undisturbed the surface tension falls progressively. Thus the values for freshly prepared solutions of sodium oletate (0·029 grm. in 100 c.c.), potassium oletate (0·0062 grm. in 100 c.c.) and potassium laureate (0·021 grm. in 100 c.c.) are found to be 49·73, 59·40 and 47·21 dynes per cm. respectively. These values fall in succession to 33·52, 45·10, and 37·64 dynes per cm. after 83, 92, and 103 minutes.

Rayleigh attributed such a deterioration of the surface tension to the action of the atmospheric carbon dioxide. As when air is replaced by hydrogen the behaviour of the surface film remains unaltered it seems more probable that the changes in the surface film arise from positive absorption.

Significantly enough the surface films of inorganic salt solutions exhibit similar properties. The surface tension of saturated solution of sodium chloride and of potassium chloride are observed to fall from 79·88 and 78·0 dynes per cm. to 73·08 and 75·52 dynes per cm. in 92 and 96 minutes respectively.

These results lead us to and demonstrate the important conclusion that substance which lower the surface tension are positively absorbed and those which increase the surface tension are negatively absorbed.

139. The Polarisation of the classical and the Raman Scattered Radiations.

K. S. KRISHNAN, Dacca.

140. The Compton Scattering and the New Statistics.

S. CHANDRASEKHAR, Madras.

141. Generalised form of the New Statistics.

S. CHANDRASEKHAR, Madras.

142. Probable upper limit to the Spatial Extension of matter.

J. GHOSH, Dacca.

143. Stress in an elliptic plate.

H. M. Sen Gupta.

144. The Lunar Atmospheric Tide at Bombay.

S. K. Pramanik.

145. Note on the magnitude scale of the astrographic Catalogue—Hyderabad Section.

T. P. Bhaskara Shastri.

146. Note on the effect of temperature on the scale value of stellar photographs.

T. P. Bhaskara Shastri.

147. Ionisation potential and structure of Methane Molecule.

S. C. Biswas, Dacca.

148. A change in the Refractive Index of Air and other Gases when an Electric Glow discharge is passing through them.

J. B. Seth *and* Bal Mukand, Lahore.

149. A change in the electrical resistance of Carbon line resistance when subjected to humid air.

J. B. Seth *and* Chetan Anand, Lahore.

150. On a probable band spectrum of Neon.

D. G. Dhavale, Allahabad.

151. Geophysical methods of prospecting.

C. L. Wadhera, Dhanbad.

152. A Markoff Perron Problem.

T. Vijayaraghavan, Annamalinagar.

Section of Chemistry.

President:—PROF. P. C. MITTER, M.A., PH.D.

Presidential Address.

"SOME ASPECTS OF BIOCHEMICAL SYNTHESIS."

LADIES AND GENTLEMEN,

I wish to offer you my heartfelt thanks for the great honour you have done me by asking me to preside over the deliberations of this section and though fully aware of my own limitations, I venture to hope that with your good will and co-operation we may bring the session to a successful issue.

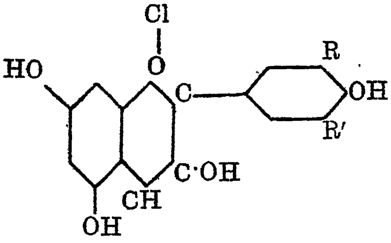
Before beginning my address, I wish to refer to the great loss which our science has suffered by the death of Prof. W. H. Perkin (jun.). Following in the footsteps of his illustrious father, Prof. Perkin incorporated in himself the highest and the best in the English School of Chemistry and the void which he has left will be difficult to fill.

I have chosen, as the subject of my address, " Some Aspects of Biochemical Synthesis ".

Although a little over a hundred years have elapsed since Wöhler by his synthesis of urea demonstrated that vital products could be synthesised in the laboratory, the mechanism of the formation of these products is still shrouded in mystery. The small temperature and pressure range between which they are formed and the absence of the usual re-agents heighten the mystery still further. Very little is known for instance about the formation of the starches, celluloses, and the proteins, not to speak of the living protoplasm which is one of the most important factors in biochemical synthesis.

The vital products might be compared to links in a long chain of which only the end members are visible and probably also a little of the beginning. But there are frequent indications in the products themselves or in the substances with which they are associated which give some clue as to their modes of formation in nature.

On *a priori* grounds, we may expect certain similarity between different classes of natural products, certain uniformity of design depending on similarity in the modes of their formation and as a matter of fact a close examination often reveals many points of resemblance between diverse classes of vital products. In products of the same class again certain distinct sub-classes are often met with. Thus, the researches of Willstätter and his pupils[1] have shown that the anthocyanins are derived from the three prototypes pelargonidine, cyanidine, and delphinidine all of which contain in the position 4′ of the phenyl radicle a free



Pelargonidine: R=H, R′=H.
Cyanidine: R=H. R′=OH.
Delphinidine: R=OH, R′=OH

hydroxyl group. The hydroxyl group in the position 3 is linked with a sugar to form the anthocyanidin while the other hydroxyl groups are either free or blocked by methyl groups or form depside linkages with acids.

Similarly for the naturally occurring anthraquinone derivatives found among plant products, the following empirical laws have been found to hold good.[2]

(1) No naturally occurring anthraquinone derivative contains more than four substituent groups in the two benzene nuclei, namely, not more than *one* methyl (or carboxyl or carbinol group) which, if present, always occupies a β-position and not more than *three* hydroxyl groups.

(2) The substances containing the maximum number of substituents from the fundamental types and the other anthraquinone derivatives occurring in the same plant are all derived from this fundamental type being either oxidation or reduction or etherification, etc., products of the same. The fundamental types are therefore also derivable by superposing the formulae of associated anthraquinones.

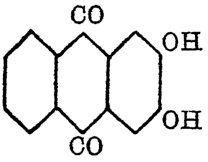
(3) Of the four substituents two (including the methyl or carboxyl or carbinol group, if present) occupy β-positions and the other two occupy α-positions.

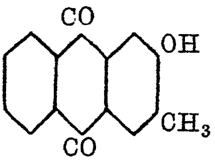
(4) If both the β-substituents are in one ring the other groups also occur in the same ring or in other words, a homonuclear type is formed. If both the β-substituents are OH groups they must occur in the same ring.

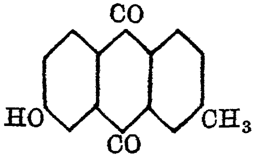
(5) If the β-substituents are in different rings the α-substituents are distributed in such a way as to produce a symmetrical configuration.

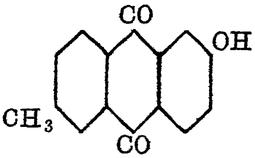
As no two types have three groups in common, it is possible by examining any one naturally occurring anthraquinone containing three substituents (sometimes even two substituents) to determine the fundamental type from which this particular substance and *all the other anthraquinone derivatives associated with it* have been derived.

Starting from anthraquinone we get by substituting two β-positions by two hydroxyl groups or by one hydroxyl and one methyl group the following types :—

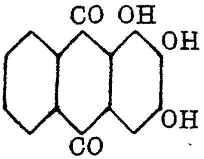




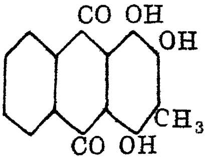




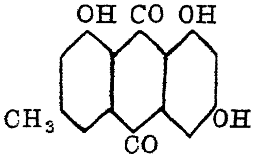
From these four β-substituted products we can derive the four fundamental types of naturally occurring anthraquinones—two homonuclear and two heteronuclear.



(I)



(II)



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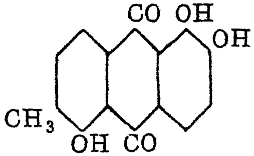


(IV)

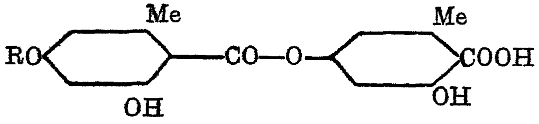
Any theory of the formation of anthraquinone derivatives in nature must therefore explain not only the formation of the anthraquinone ring system but in such a scheme the hydrozyl and methyl groups (if any) must occur in their proper places in the ring system. So, it is obvious that a theory on the basis of which we arrive at a substituted anthraquinone derivative containing a configuration of groups unlike any present in nature, cannot be regarded as a correct approximation to truth. The polyketide hypothesis of Collie[3] suffers from this obvious drawback, although it offers a satisfactory explanation of the formation of the anthocyanine, cyanidine.

The task of the organic chemist, never an easy one, becomes particularly difficult in the case of those natural products which are not available in large quantities. The recognition of the fact, however, that nature seems to favour certain definite configuration of groups to the exclusion of others has often rendered an indirect method of determination of constitutions by previous synthesis and subsequent comparison and verification, possible.

The whole mass of internal evidence is in favour not of long chains owing their origin to cellulose material but of smaller units derived partly from this source, partly from the fragments of the protein molecules and partly from formaldehyde and its condensation products. Only with such small building units is it possible to explain the great diversity of types found among vital products.

The most satisfactory explanation of the formation of an anthraquinone ring system, for instance, appears to be by the fusion of a phenolic nucleus with a benzaldehyde or benzoic acid or a second phenolic or phenolic acid nucleus and formaldehyde followed by subsequent oxidation. We are strengthened in this supposition by the fact that there are numerous other vital products in which phenolic nuclei occur and these may therefore be regarded as among the fundamental building units.

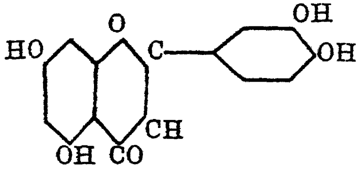
Among lichen acids, we have substances like lecanoric acid and evernic acid consisting of two phenolic acid nuclei united together by the so-called depside linkage,



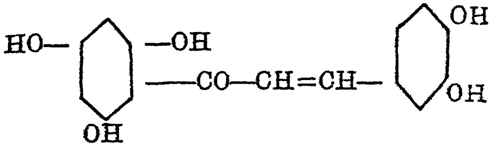
Lecanoric acid (R=H) ; Evernic acid (R=Me)

and some of the tannins contains such depsides linked with sugar molecules. Many of the anthocyanines again contain, besides the colouring matter proper with its phloroglucin component and the sugar radicles, a phenolic acid as a third constituent. As for instance, delphinine contains *p*-oxybenzoic acid and monardeine *p*-oxycinnamic acid and this phenomenon according to Karrer[4] establishes a relation between the anthocyanines and the depsides and tannins with which they are often associated in the plant.

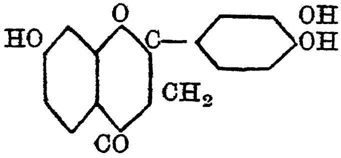
Among the vital products there are numerous ketones, some like paeonol or fisetol being fat-aromatic, others like the oxybenzophenones being diaryl ketones. The first of these two classes of ketones forms the transition to chalkones, flavones, flavonols and anthocyanines and finally to the epicatechins, and Freudenberg[5] has shown that these are all inter-related being members of an oxidation series.



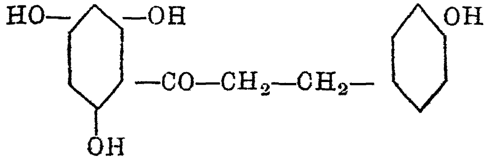
Flavone : Luteolin



Eriodictyol : Chalkone



Flavanone: Butin



Phloretin.

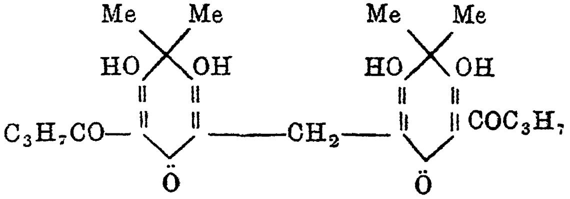
Closely allied to the flavones are the *iso*-flavones like genistein[6] which may be regarded as composed of a phenyl acetic acid nucleus, a phloroglucin nucleus and a formyl group. The first is also fairly well-distributed in nature and Gadamer[7] has shown that the alkaloids of the Chelidonium group may be regarded as derived from *N*-methyl phenylethylamine with formaldehyde and phenylacetaldehyde, the phenylacetaldehyde and phenyl ethylamine being derived from phenylalanine:

$$C_6H_5\cdot CH_2\cdot CH(NH_2)\cdot COOH \longrightarrow C_6H_5\cdot CH_2\cdot CH(OH)\cdot COOH \longrightarrow C_6H_5CH_2\cdot CHO + HCOOH \text{(Ehrlich)}$$

$$C_6H_5\cdot CH_2\cdot CH(NH_2)\cdot COOH \longrightarrow C_6H_5\cdot CH_2CO\cdot COOH \longrightarrow C_6H_5\cdot CH_2\cdot CHO + CO_2 \text{(Neubauer)}$$

$$C_6H_5\cdot CH_2\cdot CH(NH_2)\cdot COOH \longrightarrow C_6H_5\cdot CH_2\cdot CH_2NH_2 \text{ (Ellinger)}$$

There are other types in which two phenolic nuclei are united by a- CH_2-group or by a ketonic group. An example of the first type is the lichen-product albaspidin investigated by Boehm[8] which may be regarded as built up of phloroglucin, formaldehyde and butyratldehyde.[8a]

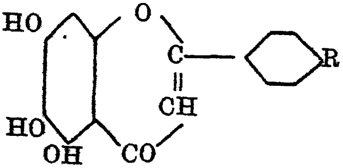


Albaspidin.

The hydroxylated diaryl ketones either occur as such or in the form of their anhydrides, the xanthones. From diaryl ketones there is a transition over 3-oxy-4-phenylchromanes to brazilin and haematoxylin and it is curious to note that the carbinol group in brazilin and haemotoxylin occupies the same position in the pyrone ring as the carbinol group in flavonols,[9] anthocyanines and even in catechin[9a]. In the laboratory a flavonol can be synthesised from a dihydric or trihydric phenol like resorcinol, or phloroglucinol, methoxyacetic acid and an aromatic acid[10] and these are probably also the building units in the vital synthesis of flavonols. We should not be far wrong if we were to attribute to the carbinol group in flavonols, anthocyanidins, catechins, and also perhaps in brazilin and haematoxylin a common origin from a glycollic acid residue.

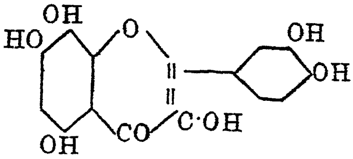
Among the phenol derivatives occurring among plant products, phloroglucin is easily the most widely distributed. The phloroglucin residue is found in oxybenzophenones like maclurin, xanthones (like gentisin) and it is fused with the γ-pyrone ring in most of the flavones and flavonols (even in an *iso*-flavone like genistein,[11]) in all the anthocyanines and also in catechin.

In a few cases, a resorcin residue is linked with the γ-pyrone ring as for instance in fisetin and in the flavanone butin while a tetrahydric phenol (oxidation product of phloroglucin) nucleus occurs in the flavones scutellarein[12] and baikalein,[13]

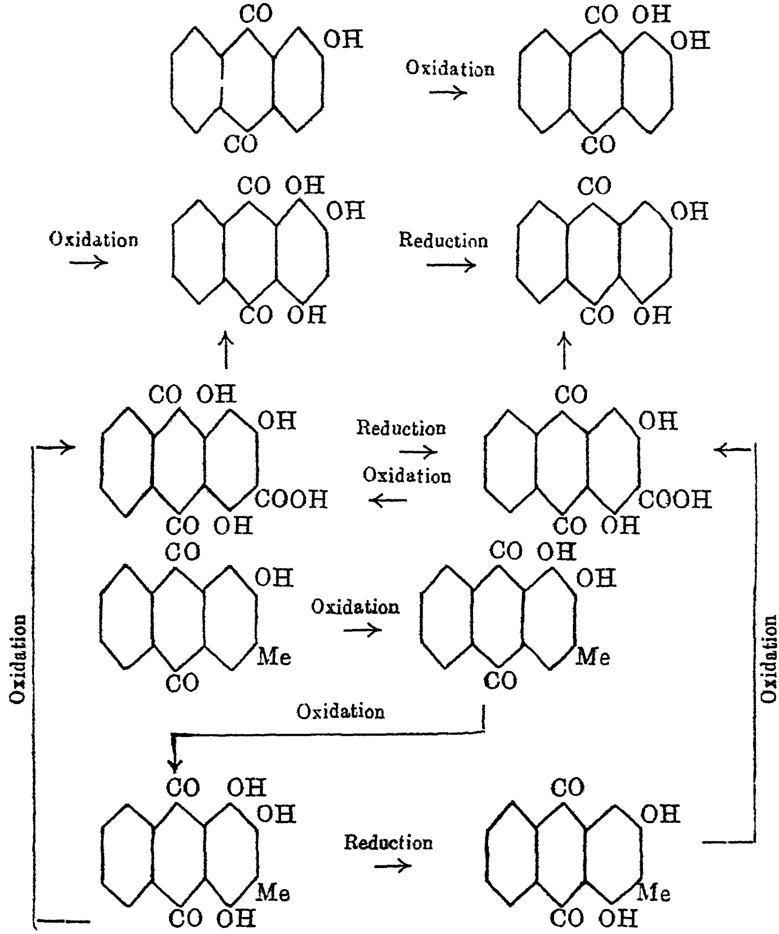


Scutellarein (R=OH)
Baikalein (R=H)

and the flavonol gossypetin[14].

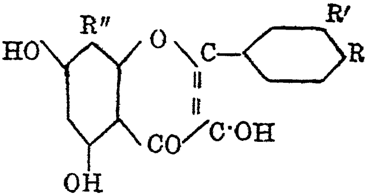


The second benzene nucleus in all the compounds mentioned above offers more variety and we have not only unsubstituted benzene nuclei, (*e.g.*, chrysin) but also hydroxyl groups in the position 2′ (datiscetin)[15], 4′ (apigenin), 2′ : 4′ (lotoflavin), 3′ : 4′ (quercetin) and 3′ : 4′ : 5′ (myricetin).



Oxidation and reduction chains are very common in nature and it has been found, for instance, that all the anthraquinones of the chayroot and madder types can be arranged in the form of such oxidation and reduction chains.[16]

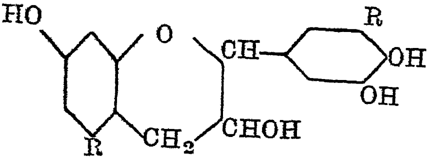
Among the flavones, flavonols, and tannins also we meet with substances so related, occurring together



Quercetin R=OH, R′=OH, R″=H;
Kaempherol R=OH, R′=H, R″=H;
Kaempherid R=OCH_3, R′=H, R″=H;
Galangin R=H, R′=H, R″=H;
Gossypetin R=OH, R′=OH, R″=OH.

as for instance, quercetin and kaemferol, kaemferid and galangin, scutellarein and baikalein, gossypetin and quercetin, and quercetin with catechin and epicatechin. The simultaneous presence of gossypetin[17] and quercetin in *Hibiscus sabdariffa* furnishes the necessary connecting link between phloroglucin and 1 : 2 : 3 : 5-tetraoxybenzene.

The observed close association in nature of allied substances in different stages of oxidation has often afforded valuable clues to the constitution of unknown substances. Thus from the fact that quercetin and catechin occur together, A. G. Perkin and Joshitake[18] had inferred a formula for catechin which was verified by Freudenberg[19] and his co-workers later on. From the fact that quebrachotannin is accompanied by fisetin and pistachiotannin by myricetin, they have predicted the formulas of some of the hypothetical catechins which are the mother substances of tannins.



Quebrachocatechin, R=H

Pistachiocatechin, R=OH

We see also that phloroglucin is one of the fundamental building units in vital synthesis forming as it were the keystone in the architecture of diverse classes of compound. Its progressive reduction would give resorcin and phenol and finally benzene and from phenol again by oxidation catechol and hydroquinone may be obtained. It is well known that phenol may be oxidised by hydrogen peroxide to catechol and the simultaneous presence of substances, containing one a phenol and the other a catechol nucleus or one a phenol and another a benzene nucleus, point to a common origin for corresponding portions of the molecules.* The ease with which phloroglucin may be methylated in the ring accounts for the presence of the methyl phloroglucin skeleton and its reduction product, the methyl resorcin skeleton which is found in rubiadin and (in its oxidised form) in euxanthone and probably also in munjisthin.

As regards phloroglucin, we can trace its origin to sugar which is the first product of carbon dioxide assimilation by the green plant. The bridge to the cyclic compounds is formed most probably by inositol which is very largely distributed in nature and which can be connected with phloroglucin by a simple relation :—

$$\underset{\text{Inositol}}{C_6H_6(OH)_6} = \underset{\text{Phloroglucin}}{C_6H_3(OH)_3} + 3H_2O.$$

The formation of a hydro-aromatic compound from an aliphatic sugar has not been hitherto observed, nor the conversion of inositol to carbohydrates. The evidence of the relation between inositol and sugar is of an indirect character. Neuberg[20] has observed that by carefully heating inositol with phosphorus pentoxide, furfurol, which has always been regarded as a true carbohydrate derivative, is obtained. Besides, the cycloses serve on the one hand as reserve material for the living organism and are on the other hand converted by bacterial action to open chain compounds like propionic, butyric, and lactic acids, thereby disclosing their biochemical relationship with the carbohydrates.[21]

As regards the pyrogallol nucleus, it may be regarded as derived from 1:2:3:5-tetraoxybenzene by reduction. It is not without interest that the root bark of *Fagara xanthoxyloides* Lam. *Rutacae* contains the substances bergapten and xanthotoxin,[22] which have a common oxidation product.

Another fundamental unit in the formation of vital products is the isoprene unit. A critical examination by Ruzicka[23] has shown that the skeletons of members of the terpene family are formed by the regular union of isoprene units in a majority of cases and irregular in others. By regular union, Ruzicka means the union of isoprene units end to end, unlike ends being joined together and it must be conceded that the majority of terpenes possess such skeletal arrangements.

Myrcene and ocimene are both formed by the union of two isoprene units in such a way that the end carbon atom of the shortest chain of one unit, is attached to the end carbon atom of the longest chain of the other, the point of reference being the tertiary carbon atom.

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* An example of peculiar biochemical interest is furnished by the pair, scutellarein baikalein, the former containing a phenolic nucleus being found in the leaves, while the latter containing an unsubstituted benzene ring occurs in the roots.

TABLE I

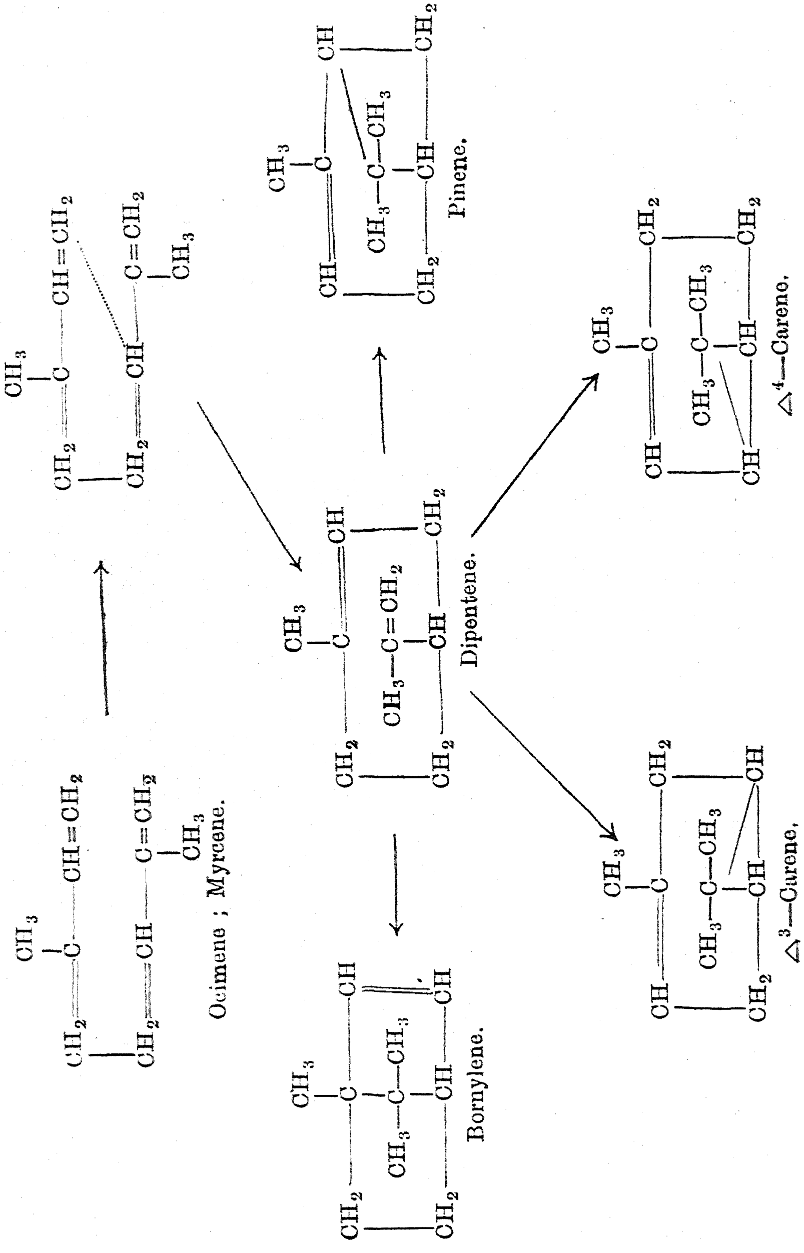
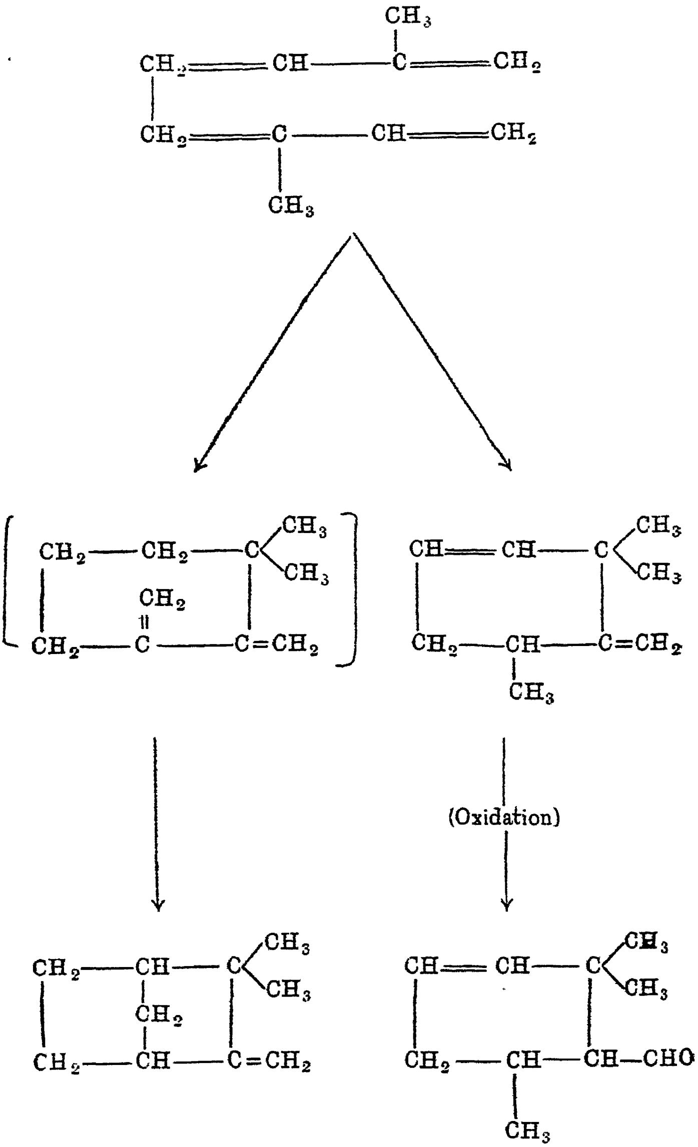

Ocimene ; Myrcene.
Dipentene.
Pinene.
Bornylene.
Δ⁴—Carene.
Δ³—Carene.

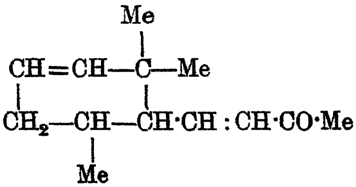
TABLE II



Camphene.

Basis of irone.

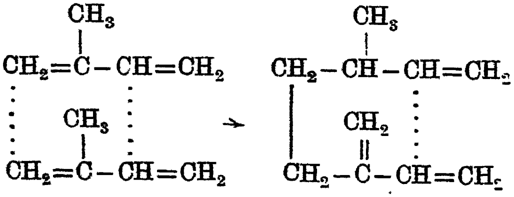
They form the transition on the one hand to the monocyclic terpenes of the *p*-cymene series, subsequent ring closing taking place in such a way as to leave the *iso*-propyl group outside the ring, giving rise to dipentene. Dipentene forms the transition to the bicyclic terpenes of the *p*-cymene series, pinene, Δ^3-carene and Δ^4-carene. Other modes of closing of the primary ring are also possible. In the first of these we have the type camphene which also forms a transition to the sesquiterpene α-santalene. It is interesting to note that cyclocitral may be regarded as formed by oxidation of the primary product and if we concede that the isoprene-skeleton is derived by the union of acetone with acetaldehyde, (both of them derivable from sugar) somewhat on the lines of one[24] of the methods of synthesis of the substance, we have the rather interesting fact

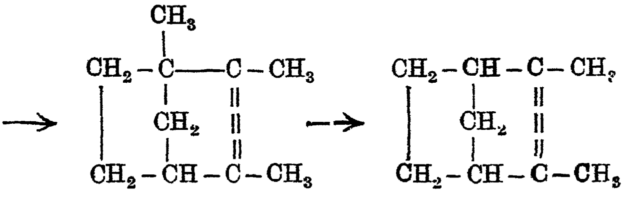


Irone.

of the irone skeleton being formed by the union of three acetone skeletons alternating with two acetaldehyde units.

As already stated before, the union of isoprene units to form the terpene skeletons is not restricted to regular union, that is to say, union by unlike ends but there are cases where the union is irregular, *i.e.*, union by like ends. If we denote the branched end of the isoprene nucleus by A and the other end by B, an union of the A – B – A – B type or of the B – A – B – A type would according to Ruzicka be regular while an union of the B – A – A – B or A – B – B – A type would be irregular. We find, however, that there are in nature instances of both types of union, although the former type predominates. Of instances of the latter we have sylvestrene where the union is of the A – B – B – A type and a compound of the B – A – A – B type is homosantene (hypothetical) whose lower homologue santene is known.





Homosantene (?) Santene.

In the case of sesquiterpenes again we know the constitution of compounds formed on the A – B – A – B – A – B model like cadenene, eudesmol, etc., but compounds formed on the B – A – A – B – B – A model are probably not absent when we find a similar constitution in substances like santonine. Judging from analogy, we can expect to find among compounds formed by the union of four isoprene units representatives of the type A – B – A – B – A – B – A – B and B – A – B – A – B – A – B – A as well as of the types A – B – B – A – A—B – B – A and B – A – A – B – B – A – A – B, and abietic acid which according to Ruzicka is formed by an "irregular" union of isoprene units[25] will be probably found to belong to one of the latter categories. Rao and Simonsen[26] have thrown some doubts on the occurrence of sylvestrene in nature and referred among others to the "anomalous" position which sylvestrene occupies being "the only naturally occurring terpene derived from *m*-cymene, all the other members of the group being *p*-cymene derivatives".

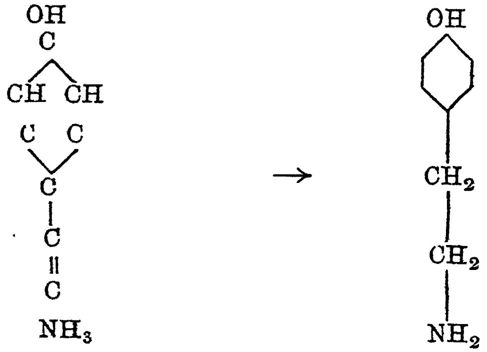
We have seen already that the "anomaly", if any, is shared by at least two other natural products santene and santonine, the first of which is a terpene.

The absence of the characteristic colour reaction of sylvestrene in the oil from *Pinus sylvestris* need not surprise us when we consider that there are other substances in the mixture which also give colour reactions and the presence of which might disguise or inhibit the colour reaction due to pure sylvestrene. A curious error which might have influenced the views of the authors occurs in this paper. They observe: "It is not without significance that Atterberg[26a] in one experiment could obtain only a dihydrochloride, m.p. 50° (the melting point of dipentene dihydrochloride) since it has been shown that in some cases Δ^4-carene on treatment with hydrogen chloride yields dipentene dihydrochloride in larger quantity than sylvestrene dihydrochloride and the former therefore crystallises on cooling. What Atterberg says, however, is this:—

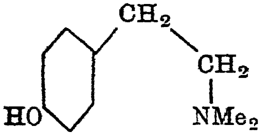
"Wie aus dem Obigen hervorgeht, ist das Sylvestren in Bezug zu den anderen bekannten Terpenen gut charakterisirt. Wie die anderen um 174° siedenden Terpene giebt es leicht ein Dichlorhydrat; dieses Chlorhydrat aber zeigt den Schmelzpunkt

72°-73° *während die anderen dargestellten Dichlorhydrate nicht höher als bei 50° schmelzen.*"

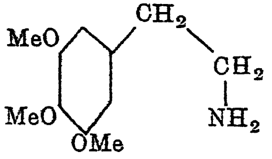
The isoprene skeleton is also met with in other natural products as for instance in the sugar, apiose $(CH_2OH)_2:C(OH)\cdot CH(OH)CHO$. The alkaloid galegin $CMe_2:CH\cdot CH_2\cdot NH\cdot C(:NH)\cdot NH_2$ furnishes an instance[27] in which an -NH- group is linked with the unbranched end of the isoprene nucleus. From a morphological point of view, it is difficult to resist the temptation of considering substances like *p*-oxy-*β*-phenylethylamine as being formed by the union of an isoprene unit with ammonia and a triose.



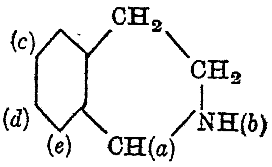
As regards the formation of alkaloids in nature we are on firmer grounds. "In any plant species in which a number of alkaloids occur it is almost invariably the case that they are closely related and can be regarded as marking stages in development." Thus the researches of Späth and his co-workers have shown that the *anhalonium* alkaloids are all closely related.[27a]



Hordenine

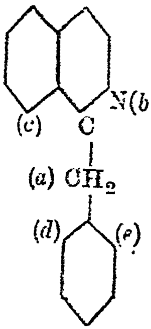


Mezcaline



Anhalamine : *a* = H, *b* = H, *c*, *d*, and *e* = OH, OMe, OMe.
Anhalonidine *o*-methyl ether : *a* = Me, *b* = H, *c*, *d*, and *e* = OMe.
Pellotine *o*-methyl ether : *a* = Me, *b* = Me, *c*, *d*, and *e* = OMe.
Anhalonine : *a* = Me, *b* = H, *c* = OMe, *d* and *e* = $.O.CH_2.O.$
Lopophorine : *a* = Me, *b* = Me, *c* = OMe, *d* and *e* = $.O.CH_2.O.$

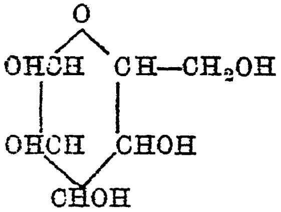
The alkaloids of the *iso*-quinoline series like papaverine, narcotine, *iso*-thebaine, berberine, etc., possess in common a benzyl *iso*-quinoline nucleus. The same primary structure, gives by the insertion of a lactone ring between *a* and *d* the skeleton present in narcotine, while the formation of a link from *c* to *d* gives the nuclear structure present in *iso*thebaine and potentially present in morphine, codeine, and thebaine. The insertion of a $-CH_2-$ bridge between *b* and *c* gives the nucleus present in berberine, while a $-CHMe-$ bridge gives the nucleus of the corydaline subgroup. From the former by a further step the characteristic central structure of the alkaloids protopine and cryptopine can be derived.



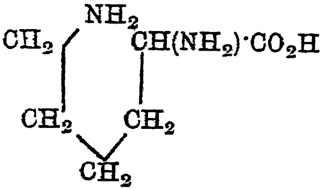
Robinson[28] has elaborated a scheme which suggests reactions by which the alkaloids might have been synthesised in plants. It involves in addition to the ordinary processes of methylation, methylenation, reduction, oxidation, and dehydration, two types of condensation to provide for the linking up of carbon to carbon, namely the aldol condensation and the condensation of carbinol-amines containing the group$=C(OH)-N=$with substances containing the group$=CH-CO-$.

The building units for the formation of alkaloids according to Robinson's scheme are the amines and amino-acids derived from the hydrolysis of proteins.

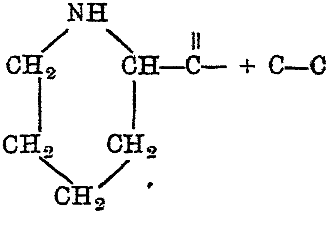
Haworth[29] has drawn attention to the intimate connection that appears to exist between the skeletal structure of the



Glucopyranose.



Lysine.



sugars and some of the amino acids. "It is very probable", writes Haworth, "that there exists a direct relationship between the carbohydrates and the proteins and it appears clear according to the following analogies that these two groups, the most important of organic derivatives, possess a common origin.

The connection of glucose with coniine, pelletierine ψ-pelletierine and *iso*-pelletierine in which the lateral chain of glucose is probably condensed with acetaldehyde or with a triose is an example. Similarly, in the case of the alkaloids of the pyrrol group like stachydrin, betonicine, etc., the lateral side chain of xylose is apparent.

There are other types of biochemical transformation of glucose, as for instance its conversion to a pyrone derivative kojic acid by the action of *Aspergillus oryzae*[30]. Besides, one of the products obtained by heating malt is α-methyl-β-hydroxy-γ-pyrone, maltol.

We see, therefore, that the units with which nature synthesises her products are largely derived from the sugars or from the proteins, at least some of which in their turn are derivable from the sugars, specially the hexoses and pentoses and it is easy to understand that there would be a tendency to exaggerate their importance. For instance, the methyl pentoses, which are fairly well represented in nature have been regarded as being formed not as primary products of biochemical synthesis but as secondary products derived from the hexoses by the reduction[31] of the terminal—CH_2OH group to a—CH_3 group. Votoček[32] has pointed difficulties attendant on such a point of view. If the pentoses were formed from the corresponding hexoses, by a reduction process of this type, *iso*-rhodeose which corresponds to glucose would have been one of the commonest of methyl pentoses. On the other hand, fucose which is actually so largely distributed in nature would have been rare, since the hexose from which it is derivable by reduction, namely *l*-galactose, is extremely rare in the vegetable kingdom. To obviate these difficulties Votoček suggests that we should seek the source of the methyl pentoses in the condensation of aldehydes containing methyl groups like acetaldehyde or perhaps lactic aldehyde with formic or glycollic or glyceric aldehyde.

In a recent communication, Robinson[33] has further elaborated a scheme indicating the relationship of some complex natural products to the sugars and amino acids and pointed out *inter alia* that the ornithine skeleton is also present in histidine, the lysine in quinine, while nicotine contains both ornithine and lysine skeletons. Harmaline and physostigmine can both be derived from the amino acid tryptophane, while in chlorophyll and haemin the sugar skeletons are perceptible.

We see, therefore, that the conditions prevailing in nature favour the formation of certain distinct classes of compounds, having common frameworks and that there are sub-classes, within these classes which differ from one another in the number and disposition of substituent groups.

The vital products belonging to different classes are sometimes related in such a way, as to mark stages in development; and when, as is often the case, such substances occur together, they offer valuable clues as to the course of the biochemical synthesis.

The building units in vital synthesis are derived partly from formaldehyde and its condensation or alteration products, chiefly the sugars and partly from the amino-acids (some of which are themselves derivable from the sugars) which are the products of protein hydrolysis, "the molecular *debris*. strewing the path of enzyme action".

The whole mass of internal evidence is in favour of comparatively small building units, without assuming which it is difficult to explain the great variety of types that are met with in nature.

Diverse products are formed in the living organism, some as the result of the anabolic, others again of the catabolic processes taking place in it and these again suffer various secondary changes like oxidation, reduction methylation, methylenation, hydrolysis, and aldol and carbinol amine condensations giving rise to the various kaleidoscopic patterns with which nature greets our eyes or delights our senses.

REFERENCES.

1.	Willstätter	Annalen, 1915, *408*, 40: 1917, *412*, 113.
2.	Mitter and Biswas	J. Indian Chem. Soc., 1928, *5*, 770.
3.	Collie	J. Chem. Soc., 1907, *91*, 1806.
4.	Karrer	Bull. Soc. Chim., 1928, *43*, 1046.
5.	Freudenberg	Ber., 1920, *53*, 1422.
6.	Baker and Robinson	J. Chem. Soc., 1926, 2713.
7.	Gadamer	Arch. Pharm. 1924, *262*, 252.
8.	Boehm	Annalen, 1901, *318*, 230; 1903, *329*, 310.
8*a*.	Schöpf and Heuck	Annalen, 1927, *459*, 261.
9.	Freudenberg, Fikentscher, and Wenner	Annalen, 1925, *442*, 312.
9*a*.	Mason	Chemistry and Industry, 1928, *47*, 275*t*.
10.	Allan and Robinson	J. Chem. Soc., 1924, *125*, 2192.
11.	Baker and Robinson	J. Chem. Soc., 1926, 2713.
12.	Bergellini	Gazzetta, 1919. *49*, ii, 47.
13.	Shibata, Iwata, and Nakamura	Acta Phytochimica, 1923, *1*, 105.
14.	Baker, Nodzu, and Robinson,	J. Chem. Soc., 1929, 74.
15.	Leskiewicz and Marchlewski	Ber., 1914, *47*, 1599.
16.	Mitter and Biswas	*loc. cit.*
17.	A. G. Perkin	J. Chem. Soc., 1899, *75*, 826.
18.	A. G. Perkin and Joshitake	J. Chem. Soc., 1902, *81*, 1162.
19.	Freudenberg, Fikentscher, Harder, and Schmidt.	Annalen, 1925, *444*, 136.
20.	Neuberg	Biochem. Zeit., 1908, *9*, 551.

21. Biochemiches Handlexikon .. II, 551.
22. Thoms and Baetcke .. Ber., 1912, *45*, 3705.
23. Ruzicka: "Über Konstitution und Zusammenhänge in der Serquiterpenereihe". (Fortschritte der Chemie, Physik und Physikalische Chemie., *19* 346).
24. Bayer and Co. .. .. D.R.P. 280226, 286920, 288271.
25. Ruzicka .. .. .. Helv. Chim. Acta, 1923, *6*, 1078.
26. Rao and Simonsen .. .. J. Chem. Soc., 1925, *127*, 2494.
26*a*. Atterberg .. .. Ber., 1877, *10*, 1208.
27. Späth and Prokopp .. Ber., 1924, *57*, 474.
27*a*. T. B. Henry .. .. "Plant Alkaloids" pp. 3, 198, Ed. 1924.
28. Robinson .. .. J. Chem. Soc., 1917, *111*, 876.
29. Haworth .. .. Bull. Soc. Chim., 1929, *45*, 17.
30. Yabuta .. .. .. J.C.S., Tokyo, 1916, *37*, 1185, 1234.
31. Fischer and Morrel .. .. Ber., 1894, *27*, 383.
32. Votoček .. .. .. Bull. Soc. Chim., 1928, *43*, 26.
33. Robinson .. .. Proc. Univ. Durham Phil. Soc., Part I, 14–59 (1927-28), Chem. Abstr., 1929, *23*, 1882.

Section of Chemistry.

Abstracts.

1. Studies on Hexammine Cobaltic Sulphate.

Pulin Behari Sarkar *and* Tara Prosad Barat, Calcutta.

The luteocobaltic hydroxide $[Co(NH_3)_6]_2(OH)_3$ is a strong base and exhibits a close analogy to the alkalis by forming insoluble chloroplatinates, chloroaurates, chloromercurates, and fluosilicates. Like the alkali sulphates hexammine cobaltic sulphate gives insoluble sulphates with the sulphates of the rare earths. Further, hexammine cobaltic sulphate forms 3 acid salts with H_2SO_4 and a double salt with Am_2SO_4. The present work was undertaken to precise the analogy of the hexammine bases with the alkalis by studying in detail the double and acid salts of the cobalt hexammine series. The double salts of $[Co(NH_3)_6]_2(SO_4)_3$ with alkali sulphates are formed by crystallising a soln. of $[Co(NH_3)_6]_2(SO_4)_3$ and alkali sulphates, *viz.*, the sulphates of K, Rb, Cs, Tl, etc. The double salts are stable only within a narrow range of concentration. Hence the equilibrium of the ternary systems, $[Co(NH_3)_6]_2(SO_4)_3$ - water—K_2SO_4 and $[Co(NH_3)_6]_2(SO_4)_3$—water—H_2SO_4 have been studied at 35°C as a result of which the formation of a double salt of $[Co(NH_3)_6]_2(SO_4)_3$ with K_2SO_4 and the existence of 3 acid salts with H_2SO_4 have been established. Their properties and ranges of stability in soln. have also been determined.

2. Analogy of diverse anions from chemical, structural, and morphological points of view.

P. B. Sarkar *and* Nirmalendunath Rây, Calcutta.

3. Preparation and properties of various salts of the complex ion BeF_4.

P. B. Sarkar *and* Nirmalendunath Rây, Calcutta.

4. Sulphate of Hexavalent Chromium.

H. R. Iyengar, Bangalore.

The solubility curve of chromium trioxide in sulphuric acid indicated the existence of a compound of trioxides of chromium and sulphur (Abstr. Sc. Congress, 1928). This compound which is a brown solid has now been identified as a sulphate of hexavalent chromium. Evidence in favour of the existence of hexavalent chromium salts is discussed.

5. A new complex pentacyano-cobalt Compound.

Priyadaranjan Rây, Calcutta.

The first instance of a pentacyano-cobalt compound was reported to the Journal of the Indian Chemical Society (Ray, 1927, 5, 3, 325). In the present paper the preparation and the properties of an entirely new bi-nuclear pentacyano-derivative have been described. The new compound has been found to be a bridge-compound with a sulphito-group and to contain a hexavalent anion. From the nature of its composition and behaviour it is concluded to be a-sulphito-pentacyano potassium cobaltiate.

6. Ammoniacal Cobalt-molybdates.

PRIYADARANJAN RÂY *and* SAILENDRA NATH MAULIK,
Calcutta.

The preparation and the properties of a number of complex cobalti-ammine molybdates have been described in the present paper. The compounds described are chloro-pentammine molybdate, aquo-pentammine molybdate, hydroxo-pentammine molybdate, molybdato-pentammine molybdate, aquo-nitro-tetrammine molybdate, nitro-molybdato-tetrammine cobalt, thiocyanato-pentammine molybdate and nitrato-pentammine-cobalti-molybdate.

7. Some derivatives of Thiosulphato-pentacyano-cobaltic acid.

PRIYADARANJAN RÂY *and* SAILENDRA NATH MAULIK,
Calcutta.

The potassium salt of the thiosulphato-pentacyano-cobaltic acid has already been described by one of us (Ray, J.I.C.S. 1927, 5, 3, 325) A large number of derivatives of the same acid have now been prepared and studied. The compounds described in this paper are the sodium, ammonium, lithium, rubidium, caesium, thallium, and a basic lead salt of the same acid. The isolation of the free acid has also been attempted and has met with partial success.

8. On the vanadates of some heavy metals.

M. B. RANE *and* K. KONDAIAH, Benares.

The vanadates of mercury, gold, thorium, cerium, and zirconium have been prepared and their properties investigated.

Mercurous vanadate Hg_2O, V_2O_5 is a reddish brown to orange compound when pure; it however varies in composition on account of oxidation, when the colour of the compound also darkens. Mercuric vanadate $2HgO, V_2O_5$ is a bright yellow crystalline compound (slightly fluorescent) readily obtained by the action of ammonium metavanadate on an aqueous solution of mercuric nitrate. On heating it gets decomposed into mercury and V_2O_5.

Gold chloride forms a compound with ammonium vanadate which is bright golden yellow when freshly made and possesses the composition $Au_2O_3, (NH_4)_2O, 2V_2O_5$; on heating, the compound first darkens in colour and then decomposes with a sharp sound giving out ammonia; it is unstable even at ordinary temperatures. Metallic gold, when left in contact with a solution of ammonium metavanadate acidified with HCl, gradually goes into solution.

ThO_2, V_2O_5, H_2O can be obtained by the action of ammonium metavanadate on thorium chloride. The bright yellow compound when heated, loses water, turns olive green, and finally decomposes into ThO_2 and V_2O_5. Thorium vanadate made from thorium nitrate and ammonium metavanadate (in hot solutions), on standing or being heated, appears to be mixed with thorium hydroxide.

Ceric vanadate, a golden yellow compound obtained from ceric sulphate and ammonium metavanadate. correspond to the formula $3CeO_2, V_2O_5, 9H_2O$. It loses water on gently heating and decomposes into CeO_2 and V_2O_5 at higher temperatures. Zirconium vanadate can be obtained as a highly gelatinous, bright yellow precipitate when a solution of zirconium nitrate is treated with ammonium metavanadate.

9. On the composition of Prussian blue and Turnbull's blue.

ABANI KUMAR BHATTACHARYA, Bareilley.

The composition of Prussian blue and Turnbull's blue were determined with varying concentrations of $FeCl_3$ and $K_4Fe(CN)_6$, and $FeSO_4$ and $K_3Fe(CN)_6$ and the following results were obtained:—

PRUSSIAN BLUE.		TURNBULL'S BLUE.	
Ratio of concentrations of $FeCl_3 : K_4Fe(CN)_6$.	Ratio of Fe : CN.	Ratio of concentrations of $FeSO_4 : K_3Fe(CN)_6$.	Ratio of Fe : CN.
1 : 1	1 : 2·50	1 : 1	1 : 2·50
$1 : \frac{3}{2}$	1 : 2·67	$1 : \frac{3}{2}$	1 : 2·53
$\frac{3}{2} : 1$	1 : 2·35	$\frac{3}{2} : 1$	1 : 2·50

The ratio of Fe: CN in Prussian blue $Fe_4''' [Fe(CN)_6]_3''''$ is 1 : 2·57 and that in Turnbull's blue $Fe_3'' [Fe(CN)_6]_3'''$ it is 1 : 2·40.

The above results show that (*a*) the ratio of Fe: CN is the same when the concentrations of the reactants of Prussian blue and Turnbull's blue are in equivalent proportions, and (*b*) the compositions of Prussian blue and Turnbull's blue are variable with the concentrations of the reactants.

From (*a*) it can be suggested that the ferric portion of Prussian blue partially oxidises the ferrocyanide portion, whilst in the case of Turnbull's blue the ferrous portion partially reduces the ferricyanide portion. Hence, it is probable that an intermediate compound results having a formula in which the ratio of Fe: CN is less than 1: 2·57, but greater than 1 : 2·40.

The variations in the composition of Prussian blue on adding excess of either $FeCl_3$ or $K_4Fe(CN)_6$ are due to the adsorption of both Fe''' and $Fe(CN)_6''''$ ions. With Turnbull's blue no remarkable change in the composition is observed with varying concentrations of either $FeSO_4$ or $K_3Fe(CN)_6$ as the adsorption of the Fe'' or $Fe(CN)_6'''$ is very small.

10. The Chemistry of Nickel Oxide in Mond's process.

MATA PRASAD *and* M. G. TENDULKAR, Bombay.

In the manufacture of nickel by Mond's process, the action of sulphuric acid on the matte obtained by roasting the ore, containing greater per cent. of copper than nickel, removes nearly all the copper but the loss of nickel does not amount to more than one per cent. Oxides of nickel dissolve very readily in acids and from the positions of nickel and copper in the electro-chemical series of elements it is expected that nickel will go in solution more readily than copper.

The distribution ratio of Ni_2O_3 and CuO and of NiO and CuO in sulphuric acid has been measured and it has been found that in the former case more nickel oxide goes in solution than copper oxide. But in the latter case the amount of nickel oxide going in solution is much smaller than copper oxide and this amount goes on decreasing as the temperature at which the nickel oxide is prepared is raised; the sample of NiO prepared at 1,000°C does not at all go in solution. Such an oxide has been prepared by heating nickel nitrate or nickel sulphate or nickel hydroxide to 1,000 C The colour of NiO also changes from black—grey-green as the temperature of preparation is changed from 400°C—1,000°C. The solubility of the oxide in sulphuric acid regularly diminishes: the density increases and the specific resistance and the magnetic susceptibility also increases.

11. Estimation of Potassium, Rubidium, and Cæsium gravimetrically by Zirconium Sulphate Method.

N. A. Yajnik *and* G. L. Tandon, Lahore.

Gravimetric estimations of potassium, rubidium, and cæsium have been carried out by the use of zirconium sulphate, which forms double sulphates with the sulphates of the above elements. The results obtained by this method are as accurate as those obtained by other well-known methods. Besides this, it is found to have a decided advantage over the other methods in the fact that the presence of ammonium ions has no effect on the accuracy of the method.

12. Interaction between nitrosyl chloride and ammonia.

G. Sambamurti *and* N. L. Narasimham, Rajahmundry.

Ammonia and nitrosyl chloride produce an amide, $NO{\cdot}NH_2$.

13. The Contact Sulphuric Acid Process.

K. W. Khubchandani.

Experiments have been conducted to test the efficiency of certain catalysts such as vanadium pentoxide and silver vanadate recently described in patent literature, for converting sulphur dioxide into trioxide. The effect of varying conditions has been studied and good results obtained in several cases.

14. The influence of adjacent groups on the stability of the double bond in unsaturated compounds. Part I. The Benzalmalonic Acids.

Sarbbani Sahay Guha-Sircar *and* Debendra Nath Datta, Dacca.

The object of the present series of investigations is to find by quantitative experiments a comparative measure of the ease with which the double bond in analogous series of carbon compounds is either ruptured or converted into a single bond, with a view to finding the influence of vicinal groups on such reactions. The carbon-to-carbon double bonds in (*a*) some substituted benzalmalonic acids, (*b*) some coumarin derivatives, and (*c*) some substituted cinnamic acids are now under investigation. The present paper refers to the first series (*a*).

The fission of the double bond in these compounds has been effected by warming in a thermostat an N/10 solution of the neutral potassium salt of the acids with the equivalent amount of an N/10 solution of phenylhydrazine hydrochloride or acetate, at the end of definite intervals taking out the samples and filtering off the aldehyde-phenylhydrazone in a Gooch crucible and drying and weighing its amount. The velocity of the double decomposition has been found to follow the bimolecular law and in 14 cases out of 16, compounds so far studied, satisfactory constants have been obtained. The formation of an oily phenylhydrazone in the remaining 2 cases rendered the method ineffective.

The work is being continued. The following are the tentative conclusions. Ortho-substituents increase the stability of the molecule no doubt by steric hindrance. Meta substituents have less influence. Para-substituents have the least effect. Of the groups chloro—, methoxy—, hydroxy—, methyl—, and nitro—, the last has the most powerful effect in stabilising the molecule.

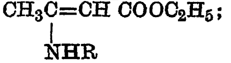
15. Synthesis of quinoline derivatives.

G. V. JADHAV, Bombay.

When ethyl acetoacetate is condensed with aromatic amines the possible reaction products can be divided into three groups:—

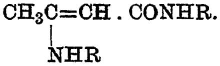
(1) $CH_3CO\,CH_2CONHR$;

(2)



$\underset{\displaystyle NHR}{CH_3C}{=}CH\ COOC_2H_5;$

(3)



$\underset{\displaystyle NHR}{CH_3C}{=}CH\,.\,CONHR.$

A substance in group (1) or (2), (*a*) when heated alone gives the corresponding substance in group (3), (*b*) when heated with sulphuric acid can give a quinoline derivative.

Knorr prepared 2-oxyquinoline derivatives starting with the condensation products of ethyl acetoacetate and aniline (and its homologues). (*Ber.*, 1884, **17**, 540). Later Conrad and Limpach obtained corresponding 4-oxy-compounds. (*Ber.*, 1888, **21**, 521). But no attempt was made to see the effect, on the synthesis, of substituents in the nucleus of the amine.

The following amines have been used:

o, *m*, and *p* chloranilines; *m* and *p* nitranilines;
p anisidine and *p* phenetidine.
m and *p*-chloraniline products give quinoline derivatives:
m and *p*-nitraniline products are decomposed and the original amines are obtained.

16. Isomerisation of benzylidene compounds.

H. S. JOIS *and* B. L. MANJUNATH, Bangalore.

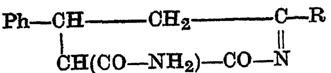
When benzaldehyde is condensed with 4: 6-dianilino-1: 3-diaminobenzene, the corresponding dibenzylidene compound is formed (bright red prisms, m.p. 165–166°). This substance is easily hydrolysed by dilute acids. However, if it is heated with solvents a colourless isomer is obtained (m.p. 281–282°). The new compound exhibits flourescence and is acted upon by dilute acids. It is probably the dibenzyl derivative of dihydroflourindene.

The nature of this kind of isomeric transformation is being investigated further with similar simple substances.

17. Reactivity of Conjugated Double-bonded Systems.

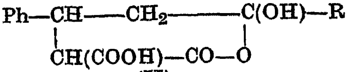
CHITTARANJAN BARAT, Calcutta.

In continuation of an earlier work, (Proc. Ind. Sci. Congress, 1928) arylidene ketones have been condensed with malonamide, when the methylene group of the latter reacts with the ethylenic bond of the ketone followed by ring closure, giving a tetrahydro-pyridone derivative (I), which retains its closed-ring constitution when subjected to alkaline hydrolysis, but forms a lactol acid (II) when hydrolysed by acids. This, on heating gives the lactol (III) by loss of CO_2, which again on dehydration is converted into the unsaturated lactone (IV); on boiling with aqueous alkali (IV) is re-converted into the original lactol (III).



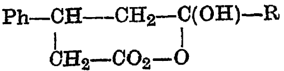
$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}C{-}R}\\ \quad|\qquad\qquad\quad\ \ \|\\ \mathrm{CH(CO{-}NH_2){-}CO{-}N}\end{array}$$

(I)



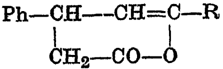
$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}C(OH){-}R}\\ \quad|\qquad\qquad\qquad|\\ \mathrm{CH(COOH){-}CO{-}O}\end{array}$$

(II)



$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}C(OH){-}R}\\ \quad|\qquad\qquad|\\ \mathrm{CH_2{-}CO_2{-}O}\end{array}$$

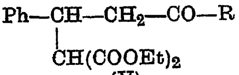
(III)



$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH{=}C{-}R}\\ \quad|\qquad\qquad|\\ \mathrm{CH_2{-}CO{-}O}\end{array}$$

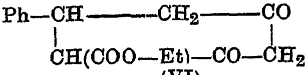
(IV)

The constitution of these latter compounds has been established by obtaining identical compounds by hydrolysing the condensation products (V) between the corresponding ketones and malonic ester; when however, $R=CH_3$, dihydroresorcinol derivatives, (VI, VII, and VIII) are obtained by the loss of a molecule of ethyl alcohol, instead of the lactol compounds.



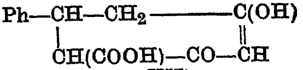
$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}CO{-}R}\\ \quad|\\ \mathrm{CH(COOEt)_2}\end{array}$$

(V)



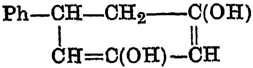
$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}CO}\\ \quad|\qquad\qquad\quad|\\ \mathrm{CH(COO{-}Et){-}CO{-}CH_2}\end{array}$$

(VI)



$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}C(OH)}\\ \quad|\qquad\qquad\quad\|\\ \mathrm{CH(COOH){-}CO{-}CH}\end{array}$$

(VII)



$$\begin{array}{l}\mathrm{Ph{-}CH{-}CH_2{-}C(OH)}\\ \quad|\qquad\qquad\quad\|\\ \mathrm{CH{=}C(OH){-}CH}\end{array}$$

(VIII)

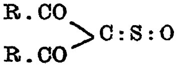
18. A study of the interaction between thionyl chloride and substances containing the reactive methylene ($-CH_2-$) group. Part I.—Formation of Sulphoxides.

K. G. Naik, R. D. Desai, *and* M. M. Parekh, Baroda.

The following substances were examined :—

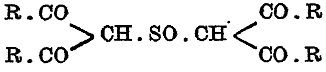
(1) Malondiphenylamide, (2) malondi-*o*-tolylamide, (3) malondi-*m*-tolylamide, (4) malondi-*p*-tolylamide, (5) malondi-(1 : 4 : 5)xylidide, (6) malondi-*α* naphthylamide, (7) malondi-*β*-naphthylamide, (8) malonmono-phenylamide, (9) malonmono-*o* tolylamide, (10) malonmono-*m* tolylamide, (11) malonmono-*p*-tolylamide, (12) malonmono-*α*-naphthylamide, (13) malonmono *β*-naphthylamide, (14) malondimethylphenylamide, (15) malon-*p*-tolylamate, (16) malon-*o*-tolylamate, (17) malondimethylamide, (18) malondiethylamide, (19) malondipropylamide, (20 and 21) malondibutylamide (normal and *iso*), (22) malonamide, and the amides of methylmalonic acid.

Of the above (1) to (16) gave sulphoxides of the general formula :



$$\begin{array}{l}\mathrm{R.CO}\\ \qquad\quad >\mathrm{C:S:O}\\ \mathrm{R.CO}\end{array}\qquad\text{(I)}$$

In the case of (17) and (18) substances of the general formula



$$\begin{array}{l}\mathrm{R.CO}\qquad\qquad\qquad\qquad\quad\mathrm{CO.R}\\ \qquad\quad >\mathrm{CH.SO.CH}<\\ \mathrm{R.CO}\qquad\qquad\qquad\qquad\quad\mathrm{CO.R}\end{array}\qquad\text{(II)}$$

were obtained; (22) did not react at all, while in all the other cases, though there was a vigorous reaction, it was not possible to get the end-products, owing to the very unstable nature of these compounds.

The sulphoxides having the constitution (I) are very unstable, and are decomposed even by moist air, while those having the constitution represented by (II) are fairly stable.

The reactivity of the hydrogen atoms of a methylene group is influenced in much the same way by the adjacent groupings as was observed by Naik and his collaborators.

19. A study of the interaction between thionyl chloride and substances containing the reactive methylene ($-CH_2-$) group. Part II.—Conversion of Sulphoxides into Sulphides.

K. G. Naik *and* M. M. Parekh, Baroda.

It was observed during the action of thionyl chloride on malondiphenylamide, that when the action of $SOCl_2$ is continued for four hours a compound having the constitution,

$$(C_6H_5NHCO)_2C:S:C(CONHC_6H_5)_2$$

is obtained. This action has been studied in the case of the other substituted amides. They are:—

(1) Malondiphenylamide, (2) malondi-*o*-tolylamide, (3) malondi-*m*-tolylamide, (4) malondi *p*-tolylamide, (5) malondi-α-naphthylamide, (6) malondi-β-naphthylamide, (7) malonmonophenylamide, (8) malonmono-*m*-tolylamide.

All these give rise to the sulphides of the general formula, $[(RNHCO)_2C]_2S$; in the case of (5) and (6), however, besides these sulphides, by-products containing no sulphur and having melting points higher than those of the original amides were obtained, which are still under investigation.

An examination of the reaction in the presence of (*a*) dry hydrochloric acid gas and (*b*) iodine, as catalysts, shows that the conversion of the sulphoxides into sulphides is due to the catalytic action of thionyl chloride.

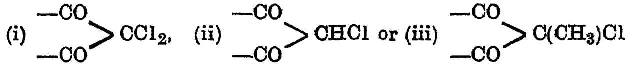
20. Interaction of iodine monochloride with substances containing the reactive methylene ($-CH_2-$) group.

K. G. Naik *and* C. C. Shah, Baroda.

This work was undertaken to prepare the iodo-derivatives of the substituted malonamides. The re-agent employed was iodine monochloride, and its interaction with the following compounds was studied:—

(1) Malondipropylamide, (2) malondiheptylamide, (3) malonamide, (4) malondibenzylamide, (5) malondiphenylamide, (6) malondi-*o*-tolylamide, (7) malondi-*p*-tolylamide, (8) malondimethylphenylamide, (9) malondi-α-naphthylamide, (10) malon monophenylamide, (11) malonmono-*p*-tolylamide, (12) methylmalondiphenylamide, (13) methylmalondi-*o*-tolylamide.

Contrary to the expectations, only chloro-derivatives of the type,



$$\text{(i)}\ \begin{matrix}-CO\\-CO\end{matrix}\!\!>CCl_2,\quad \text{(ii)}\ \begin{matrix}-CO\\-CO\end{matrix}\!\!>CHCl\ \text{or (iii)}\ \begin{matrix}-CO\\-CO\end{matrix}\!\!>C(CH_3)Cl$$

were obtained as the only reaction products. In some cases chlorination of the nucleus also takes place. This formation of the chloro-compounds has been explained as being due to the very unstable nature of such iodo-compounds (cf. Willstätter, *Ber.* 1902, **35**, 1377). The course of the reaction is represented as under:—

$$(RNHCO)_2CH_2+2ICl=(RNHCO)_2CI_2+2HCl$$

$$(RNHCO)_2CI_2+2ICl=(RNHCO)_2CCl_2+2I_2$$

21. Studies in the Ligno-cellulose Group. Part III.—Saccharification of *Excoccaria Agallocha* and its acetylation.

H. K. Sen, Patitpaban Pal, *and* Sushil Kumar Bose, Calcutta.

In order to obtain a better insight into the nature of combination, if any, between lignin and cellulose, and also into whether the cellulose complex itself is uniform, following acids were used for saccharification: formic, acetic, monochloracetic, trichloracetic, benzenesulphonic, sulphuric, and hydrochloric acids.

Excoccaria of comparatively mature growth has the following approximate composition :—

Moisture	16·48%
Soluble in cold water	1·03%
Soluble in hot water	2·87%
Fat, wax, resin, etc.	1·06%
Soluble in 1% caustic soda solution	11·91%
Cellulose by Cross and Bevan's method	43·18%
Cellulose by chlorine peroxide method	55·79%
Lignin	31·51%
Pentosan	16·28%
Ash	2·43%

The destruction of hemicellulose in the isolation of cellulose by Cross and Bevan's method, and its retention in the chlorine peroxide method is shown in the table below :—

(Composition of cellulose by Cross and Bevan's method).		(Composition of cellulose by chlorine peroxide method).	
α-Cellulose	72·73%	α-Cellulose	55·77%
Hemicellulose	27·27%	Hemicellulose	44·23%
Pentosan	7·26%	Pentosan	25·72%

Acetylation by boiling with acetic anhydride usually gave an acetate insoluble in acetone or chloroform, corresponding to a diacetate, whilst acetic acid—acetic anhydride—sulphuric acid mixture invariably gave a soluble triacetate unmixed with lignin. It is conjectured that the sulphuric acid acts far more drastically than is ordinarily believed, and causes the elimination of lignin from the complex, giving rise at the same time to a hydroxyl group which is simultaneously acetylated.

Saccharification by various acids at different dilutions and under various pressures leads to the conclusion that a sort of equilibrium is established between the cellulose and the sugar, which latter is decomposed in contact with the acid under the condition of digestion. A comparatively young tree gave a much higher percentage of fermentable sugar giving frequently as high as 40 gallons of spirit per ton of saw dust. This would seem to indicate the need for selecting the age of a tree for technical utilisation as a source for power alcohol, provided of course the timber quality does not materially suffer thereby.

The hydrolysis of saw dust by organic acids of various strengths points to the probable existence of differently polymerised bundles.

22. 3-Sulphosalicylic acid.

N. W. Hirve, Bombay.

3-Sulphosalicylic acid has been obtained from 3-sulpho-5 nitrosalicylic acid by removal of the -NO_2 group in the usual way (reduction, diazotisation, and reduction).

3-Sulphosalicylic acid, which is new, is distinct from the well-known 5-sulphosalicylic acid in respect of various properties, *e.g.*, melting point and water of crystallisation in the acids and their salts.

The constitution of 3-sulphosalicylic acid has been proved (*a*) by nitrating it, when the original 5-nitro-3-sulphosalicylic acid was obtained; (*b*) by bromination, when 3-sulpho-5-bromosalicylic acid was obtained which on distillation with super-heated steam gave 5-bromosalicylic acid.

23. 4-Sulphosalicylic acid.

N. W. HIRVE *and* M. R. JAMBHEKAR, Bombay.

4-Sulphosalicylic acid may conceivably be synthesised in two different ways from (*a*) *o*-nitrotoluene and (*b*) *o*-cresol.

(*a*) *o*-Nitrotoluene when sulphonated with fuming sulphuric acid gives 2-nitrotoluene-*p*-sulphonic acid; this on oxidation gives 2-nitro-4-sulphobenzoic acid. 4-Sulphosalicylic acid has been obtained from the above acid on substituting $-NO_2$ by -OH in the usual way.

(*b*) *o*-Cresol on sulphonation with fuming sulphuric acid is said to give 2-hydroxy-*p*-toluene sulphonic acid, which on further oxidation should give 4-sulphosalicylic acid.

24. 3-Nitro-2-hydroxy-4-methoxybenzaldehyde and its derivatives.

M. SESHAIYENGAR *and* K. SANTHANAM, Bangalore

The nitration of 2-hydroxy-4-methoxybenzaldehyde gives a very small yield of the 3-nitro-derivative (I.Sc. Congress, 1925). The best method to obtain a greater yield has been worked out. The methyl ether of the 3-nitro-aldehyde melts at 85–86° and its ethyl ether at 57°.

On treatment with bromine it gave a mono-bromo-derivative melting at 126° identical with one of the products obtained by nitrating 5 bromo-2-hydroxy-4-methoxybenzaldehyde and a dibromo-compound melting at 127–128° identical with the dibromo-derivative obtained by brominating 6-nitro-resorcyl-3-methyl-ether. On reduction with sodium hydrosulphite and applying Sandmeyer's reaction a bromo-derivative melting at 108–110° was obtained.

The paper deals with the constitution and reactions of the derivative so obtained.

25. Molecular re-arrangement during bromination.

M. SESHAIYENGAR *and* K. SANTHANAM, Bangalore.

In continuation of a previous paper (Ind. Sc. Congress, 1929) it is noticed that when 3-nitro-2-hydroxy-4-methoxybenzaldehyde is brominated it gives rise to a product identical with the dibromo-derivative obtained by brominating the 5-nitro-isomeride. The experiments conducted so far indicate definitely that the re-arrangement does occur during bromination. Instances of exchangeability of nitro-groups by halogen atoms are known (Monatsh., 1925, **46**, 91) as also the substitution of the aldehyde groups by nitro groups; replacement of halogens by nitro-groups is also common. The paper deals with the discussion whether the molecular re-arrangement is an effect of two successive substitutions, or whether it is due to a wandering of the nitro-group.

26. Condensation of acetone dicarboxylic acid with phenols and phenolic ethers.

D. B. LIMAYE *and* V. M. DIXIT, Poona.

During the synthesis of coumaryl-4-acetic acid (J. Indian Chem. Soc. 1927, **4**, 154, by one of us (D.B.L.) the formation of a by-product was observed which was thought to belong to the *para* series. This observation has been confirmed, a modified process giving greater yield worked out, and the reaction extended to phenolic ethers. Thus phenol gives a dicarboxylic acid ($C_{11}H_{10}O_5$, m.p. 184° decomp.), the methyl ether of which (m.p. 176° decomp.) gives on oxidation, anisic acid, proving condensation in the *para* position. Anisol gives a methylated dicarboxylic acid identical with the above ether. *o*-Cresol methyl ether also gives a similar dicarboxylic acid.

27. On Asymmetric Synthesis.

P. NEOGI *and* MD. ISAQUE, Calcutta

The synthetic preparation of both *d*- and *l*- modifications of *α*-*β*-dibromo-cinnamic acid by the bromination of cinnamic acid in the presence of alkaloids has been attempted.

28. On Asymmetric Synthesis of Organic Sulphur Compounds.

B. K. MENON *and* P. C. GUHA, Bangalore.

Smiles in 1905 attempted this synthesis by the addition of *l*-menthyl brom acetate to methyl ethyl sulphide and subsequent removal of the menthyl group by hydrolysis. The resulting thetine was, however, found to be inactive. It was expected that the chances of racemisation due to free rotation of a thetine obtained from a closed ring sulphide are likely to be less due to the spiran structure of the compound. The hydrolysis of l-menthyl ester of methyl tetra methylene thetine bromide with concentrated hydrochloric acid resulted in an inactive compound. Further work in this line using alkaloidal salts of unsymmetrical thetine bromides in place of l-menthyl ester of thetine bromides is in progress.

29. A new method of conversion of coumarins to *ortho*-coumaric acids.

R. N. SEN *and* D. CHAKRAVARTI, Calcutta.

A new method of effecting readily the conversion of substituted coumarins into *ortho*-coumaric acids by means of (*a*) yellow mercuric oxide, and (*b*) mercuric acetate is described. Coumarins, having negative substituents in the 6 position (such as the nitro-, aldehydo-, iodo-, dichloro (6: 8)-, di-bromo (6: 8)-coumarins are quantitatively converted to *ortho*-coumaric acids when their dilute alkaline solution is boiled for half an hour with a small quantity of yellow mercuric oxide.

Similar conversion of 6-nitro-, 6: 8-dichloro-, and 6: 8-dibromo-coumarins to the corresponding *ortho*-coumaric acids also takes place very readily with quantitative yields by adding an aqueous solution of mercuric acetate to a caustic soda solution of the coumarins neutralised with acetic acid in the cold, dissolving the precipitate in cold caustic soda and re-precipitating with dilute hydrochloric acid. In the case of coumarin, however, a dimercury derivative of *ortho*-coumaric acid is first formed which when boiled with hydrochloric acid, gives a quantitative yield of *ortho*-coumaric acid.

30. On mercuration of coumarins.

R. N. SEN *and* D. CHAKRAVARTI, Calcutta.

6-Chloro-mercuricoumarin and 6: 8-dichloro-mercuri-coumarin have been obtained by boiling a dilute alkaline solution of coumarin with yellow mercuric oxide for three to four hours and then acidifying with dilute hydrochloric acid in the cold in the same way as was done by White (J.A.C.S. 1920, **42**, 2355) for mercurating the phthaleins. The behaviour of these compounds towards sodium carbonate and bicarbonate solutions and caustic alkalis is exactly similar to that of coumarin itself. 4-7-Dimethyl-6 : 8-dichloro-mercuri-coumarin has been obtained from 4 : 7-dimethyl-coumarin in the same manner. 6-Substituted coumarins are not thus mercurated but are converted to the corresponding *ortho*-coumaric acids.

A diacetoxy-mercury derivative of *ortho*-coumaric acid is obtained by neutralising an alkaline solution of coumarin with acetic acid and adding an aqueous solution of mercuric acetate to the solution of the coumarinic acid. A quantitative yield of *ortho*-coumaric acid is obtained from this dimercury derivative by treatment with moderately dilute hydrochloric acid. The indentical dimercury derivative is also obtained when an alkaline solution of *ortho*-coumaric acid is boiled with yellow mercuric oxide and acidified with acetic acid.

By similar treatment with mercuric acetate β-methyl-umbelliferone gives 4-methyl-7-hydroxy-6: 8-diacetoxy-mercuri-coumarin, while β-methyl-daphnetin gives a dimercury derivative in which the mercury atoms are attached to the oxygen.

N-mercuri-amino-coumarin is obtained when an acetic acid solution of 6-amino-coumarin is warmed to 60–70° with an aqueous solution of mercuric acetate.

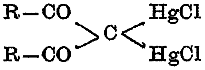
31. Mercuration of compounds containing the reactive methylene (CH_2-) group.

K. G. Naik *and* C. C. Shah, Baroda.

The mercuration was carried out by means of mercuric chloride in presence of sodium bicarbonate and glycerol (Neogi and Chatterji, J.I.C.S. 1928, **5**, 221). The following compounds were mercurated :—

(1) Malonamide, (2) malondimethylamide, (3) malondiethylamide (4) malondipropylamide, (5) malondibutylamide, (6) malondi-*iso*-butylamide, (7) malondiamylamide, (8) malondi-*iso*-amylamide, (9) malondiheptylamide, and (10) malonic ester.

These gave rise to mercurated products having the general formula :



$$\begin{matrix} R-CO \\ R-CO \end{matrix} > C < \begin{matrix} HgCl \\ HgCl \end{matrix}$$

The action of (*a*) concentrated hydrochloric acid, (*b*) aqueous and alcoholic potassium iodide, (*c*) hydrogen sulphide and (*d*) sodium thiosephate on $(ClHg)_2\,C : (COOC_2H_5)_2$, dichloromercuri-malonic ethyl ester, and of (*a*) alcoholic potassium iodide, and (*b*) concentrated hydrochloric acid on dichloromercuri-malondiheptylamide has been studied; it was found that they behave generally as organo-mercury compounds having mercury attached to a carbon atom in α-position to a keto-group.

32. Condensation of *m*-Cresotic Acid with Chloral.

N. M. Shah *and* R. L. Alimchandani, Dharwar.

The condensation of *m*-cresotic acid with chloral in presence of sulphuric acid gives a complex mixture of substances from which 3 products have been insolated: 3-hydroxy-6-α-hydroxy-βββ-trichloroethyl-*p*-toluic acid (A), ωω-dichloro-5-carboxy-2-methyl-4-hydroxyacetophenone (B), and a third substance which is under investigation. (A) on treatment with zinc and acetic acid gives 3-hydroxy-6ββ-dichloroethyl-*p*-toluic acid (C), the methyl ether of which was previously obtained by Meldrum and Alimchandani (J.I.C.S., 1925, **2**, 4). (B) by similar treatment undergoes a change in which the group -CO.$CHCl_2$ becomes -CH_2. CH_3. On hydrolysis (A) yields a substituted mandelic acid while on oxidation it gives α-coccinic acid (Meldrum and Alimchandani, J.I.C.S., 1929, **6**, 253). (C) on treatment with sulphuric acid undergoes a change in which the group -CH_2. $CHCl_2$ by hydrolysis and oxidation becomes -CH_2. CO_2H.

When, however, the solution of *m*-cresotic acid and chloral in sulphuric acid is saturated with hydrochloric acid, the main product of the reaction is 3-hydroxy-6-αββ-tetrachloro-*p*-toluic acid with small quantities of two other substances which are under investigation.

33. Formation of phthalides from substituted *m*-oxybenzoic acids.

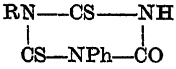
P. C. Mitter *and* P. K. Paul, Calcutta.

Edwards, Perkin, and Stoyle have prepared meconines by the action of formaldehyde and hydrochloric acid on veratric and *o*-veratric acids (J.C.S., 1925, 197). Later, Ray and Robinson (J.C.S., 1925, 1620) have found that the yield of meconines is improved by using acetic acid as solvent. In extending the experiments to gallic and myristicic acids it was found that while the first method gives phthalides Perkin and Stoyle's modification gives chloro-methyl phthalides, which can also be prepared by the action of formaldehyde and hydrochloric acid on the acetic acid solution of phthalides prepared by the first method.

34. Extension of Michael's Reaction. Part II.—Action of Urethane on Mustard oils and *iso*Cyanates.

T. N. Ghosh *and* P. C. Guha, Bangalore.

Urethane reacts equally well with mustard oils and *iso*cyanates to form addition compounds of the type RNH—CS—NH—COOEt (type I) and RNH—CO—NH—COOEt (type II). In the case of the aromatic mustard oils the carbethoxy-thioureas (type I) cannot be isolated because as soon as they are formed they yield compounds like type (III) by reacting further with mustard oils.



This explanation has been confirmed by preparing identical compounds (of type III) by allowing carbethoxy thioureas (prepared by Doran's method) to react with mustard oils. Carbethoxyureas (type II) however, show no tendency to react with mustard oils and *iso*cyanates.

35. Isomeric Iminothiobiazolones and Iminothiolthiobiazoles.

S. L. Janniah *and* P. C. Guha, Bangalore.

The isomerism of hydrazodithiodicarbonamide and the substituted hydrazide has been further established by a study of their absorption spectra and other physical properties. Some new ring compounds have been obtained by the action of hydrochloric acid on the hydrazides and their relation to endoxy-aminothiobiazole has also been elucidated from their absorption spectra curves.

36. α-Oxy-β-phenylthiocarbamide.

P. P. PATEL *and* P. C. GUHA, Bangalore.

Though Fisher (Ber., **22**, 1935), Kall. (Ann., **263**, 260) and Voltmer (Ber., **24**, 380) succeeded in preparing α-oxy-β-phenylthiocarbamide after the failure of Schiff (Ber., **9**, 574) in the same attempt, they got low yields and their procedure was tedious. A quantitative yield of the pure crystalline compound has now been obtained easily, by modifying the older methods.

By boiling with alcohol and water, the compound is converted into two isomeric triphenyl*iso*melamines and not into a furodiazole derivative as mentioned in Indian Science Congress Abstract (1928, p. 157). Hot dilute HCl converts it into phenylcarbamide and sulphur. The compound gets decomposed into the same products even when kept in vacuum over sulphuric acid. On treating a cold aqueous alkaline solution with iodine it decomposes into phenyl*iso*cyanide and sulphur.

37. Mixed Hydrazodithiodicarbonamides and their Ring-Closure.

P. P. PATEL *and* G. C. CHAKRAVARTI, Bangalore.

Several mixed hydrazodithiodicarbonamides have been obtained by the action of different mustard oils upon 4-substituted thiosemicarbazides, *viz.*, 1-phenyl-6-*o*-tolyl, 1-phenyl-6-*m*-tolyl, 1-phenyl-6-*m*-xylyl, 1-*o*-tolyl-6-*m*-xylyl, 1-*m*-tolyl-6-*m*-xylyl and 1-*o*-tolyl-6-*m*-tolyl—hydrozo-dithiodicarbonamides.

2 : 5-Phenyl-*o*-tolyl, 2 : 5-phenyl-*m*-tolyl, 2 : 5-phenyl-*m*-xylyl, 2 : 5-*o* tolyl-*m*-xylyl, 2 : 5-*m* tolyl-*m*-xylyl and 2 : 5-*o*-tolyl-*m*-tolyl—diimino-2 : 3 : 4 : 5-tetrahydro-1 : 3 : 4-thiodiazoles obtained by oxidation by iodine from the above mixed hydrazo-compounds, melt respectively at 200°, 216°, 189°, 205°, 190°, and 190°.

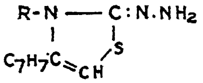
Diacetyl derivatives of these thiodiazoles melt respectively at 223°, 177°, 120°, 224°, 263°, and 231°.

Boiling with pyridine also causes ring-closure of the hydrazo-compounds to yield the same thiodiazoles.

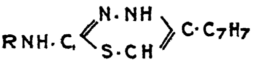
38. Thiodiazines. Part VI.

BIRENDRA KUMAR NANDI *and* PRAFULLA KUMAR BOSE, Calcutta.

The condensation of *p*-methyl-ω-bromoacetophenone with thiosemicarbazides, R. NH. CS. NH. NH_2 (R=H, Alkyl or Aryl) was expected to yield both I and II (cf. Bose, J. Indian Chem. Soc., 1924, **1**,50).



(I)



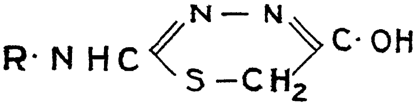
(II)

In fact, it was found that when R=H, the product has the constitution I. If, however, R is an alkyl or aryl group, the products are found to have the structure II. These results indirectly point out that the ketonic group of *p*-methyl-ω-bromoacetophenone is comparatively less active towards the -NH. NH_2 group of thiosemicarbazide than the bromine atom towards the potential thiol group (cf. Guha and Roy-Chowdhury, J. Indian Chem. Soc., 1928, **5**, 153).

39. Thiodiazines. Part VII.

Birendra Kumar Nandi *and* Prafulla Kumar Bose,
Calcutta.

Chloracetic acid or its ester readily condenses with thiosemicarbazide and 4-substituted thiosemicarbazides forming compounds which, from a consideration of their properties, appear to possess the structure.

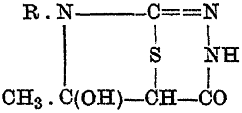


They form monoacetyl and methyl derivatives in the usual way. Thiazoles are not formed in the above condensation even as by-product.

40. Thiodiazines. Part VIII.

Prafulla Kumar Bose *and* Birendra Kumar Nandi,
Calcutta.

The condensation of α-chloroacetoacetic ester and 4-substituted thiosemicarbazides leads to the formation of compounds having the general formula, $R.C_5H_6O_2N_3S$. They do not contain the $:N.NH_2$ or CO_2Et groups. Moreover, they do not condense with re-agents for ketones or give colouration with ferric chloride. These considerations have led the authors to suggest the following formula.



$$\begin{array}{ccccc} R.N & — & C & = & N \\ | & & | & & | \\ | & & S & & NH \\ | & & | & & | \\ CH_3.C(OH) & — & CH & — & CO \end{array}$$

The products are well-defined crystalline substances and are soluble in alkali or acids but not in carbonate solution.

41. A qualitative test for nitro-groups in organic compounds.

Prafulla Kumar Bose, Calcutta.

Aliphatic mono-nitro compounds and poly-nitro-derivatives of benzene, when heated for a short time with concentrated potassium hydroxide solution, break up, at least partly, according to the equation,

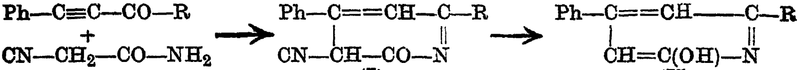
$$R.NO_2+KOH=R.OH+KNO_2.$$

The products after acidification give tests for nitrous acid. Since very delicate tests for nitrous acid are available, the above constitutes a very handy method for the detection of the NO_2 group in the laboratory. The mono-nitro-derivatives of benzene so far investigated gave negative results.

42. Condensation of acetylenic ketones with cyanoacetamide.

Chittaranjan Barat, Calcutta.

Acetylenic ketones have been condensed with cyanoacetamide in the presence of sodium ethoxide, to form cyano-pyridone derivatives (I), which on hydrolysis gave rise to substituted hydroxy-pyridines (II), identical with compounds obtained by similarly condensing cyanoacetamide and malonamide with arylidene ketones, followed by dehydrogenation and hydrolysis of the condensation products thereby obtained.



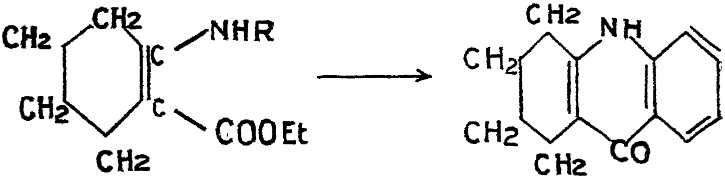
$$\begin{array}{c} Ph-C\equiv C-CO-R \\ + \\ CN-CH_2-CO-NH_2 \end{array} \longrightarrow \begin{array}{l} Ph-C=CH-C-R \\ \qquad | \qquad\quad\ \ \| \\ CN-CH-CO-N \end{array} \longrightarrow \begin{array}{l} Ph-C=CH-C-R \\ \qquad | \qquad\qquad \| \\ CH=C(OH)-N \end{array}$$

(I) (II)

43. Formation of heterocyclic compounds. Part V.—Synthesis of some tetrahydroacridones.

H. K. Sen *and* Umaprosanna Bose, Calcutta.

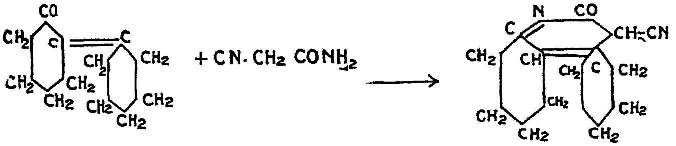
The present work deals mainly with the interaction of ethyl *cyclo*hexanone—2—carboxylate with certain aromatic primary amines at the ordinary temperature. It was already shown (J. Indian Chem. Soc., 1929, **6**, 309) by us that at higher temperatures anilides are formed which could be subsequently converted into tetrahydrophenanthridones in the presence of concentrated sulphuric acid. Working at ordinary temperature, anils are formed which on being heated up to boiling temperature, gave tetrahydroacridones.



44. Formation of heterocyclic compounds. Part VI.—Condensation of *cyclo*hexylidene *cyclo*hexanones with cyanacetamide.

H. K. Sen *and* Nirmal Kumar Neogi, Calcutta.

The condensations have been carried out in the presence of sodium ethoxide in molecular proportions in absolute alcoholic medium, the sodium salt of the condensation product being decomposed by passing a current of carbon dioxide. *Cyclo*hexylidene *cyclo*hexanones yielded the following type of compounds :—

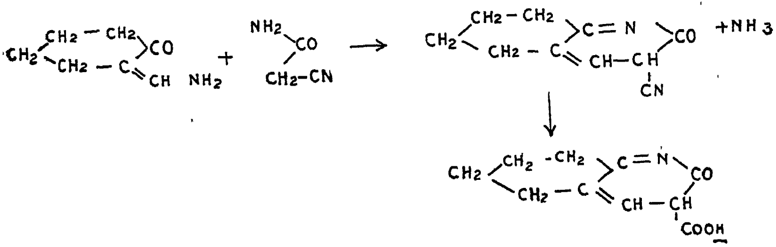


Hydroxymethylene ketones of the *cyclo*hexylidenes were also prepared and condensed with cyanacetamide and their difference with the above class of compounds investigated.

45. Formation of heterocyclic compounds. Part VII.—Behaviour of conjugated double bonded systems with cyanacetamide.

H. K. Sen *and* Kanailal Mandal, Calcutta.

In order to exclude the directive influence of sodium ethoxide or Knoevenagel re-agents, the condensation of the amide of hydroxymethylene *cyclo*hexanone with cyanacetamide was conducted by simply heating the two in molecular proportions at 140°C. The identity of this product m.p. 310° with the condensation product obtained previously from hydroxymethylene *cyclo*hexanone and cyanacetamide in the presence of catalysts was established by hydrolysis.



Similar condensation product has been obtained from the amide of hydroxymethylene camphor and cyanacetamide.

When the amide of hydroxymethylene *cyclo*hexanone is treated with a slightly alkaline solution of hydroxylamine, the oxime of cyano*cyclo*hexanone is formed which is indicative of the position of the amido group in the hydroxymethylene *cyclo*ketone. The study of the absorption spectra of the amide and the anilides of the hydroxymethylene *cyclo*ketones also throws light on the reactivity of the conjugated double bond.

46. Studies in Sulphur Containing Dyestuffs. Part II.—Substituted phenylthioxanthenes and their derivatives.

M. V. Betrabet *and* G. C. Chakravarti, Bangalore.

Condensation of hydroxybenzhydrols with aromatic mercaptans in the presence of zinc chloride gave highly insoluble red substances with zinc in the molecules. The same condensations when carried out in the presence of freshly prepared zinc chloride with dry HCl gas in occlusion yielded the same type of compounds in greater yields. A constitution and the course of reaction has now been proposed for them. The elimination of zinc from the compounds yielded the corresponding thioderivatives. In these condensations some alkali insoluble products were isolated which on hydrolysis with alcoholic potash yielded hydroxy phenylthioxanthenes.

The yields of these being not satisfactory other methods of preparation were tried, and finally similar phenylthioxanthenes were obtained by condensing substituted diphenylsulphides with aromatic and substituted aromatic aldehydes.

47. Colour of Complex diazoles. Part V.—Constitution of Thiele's supposed *o*-Benzylene—1 : 3—benziminazole.

M. V. Betrabet *and* G. C. Chakravarti, Bangalore.

Condensation of phthalaldehyde with *ortho*phenylene diamine should lead to the formation of benzylyl-*o*-phenylene diamine (I). But Thiele and Falk (*Annalen* 1906, **347**, 112) considered the product of this reaction to be *o*-benzylene—1 : 3—benziminazole (II). In an attempt to prepare compound (II) by condensing phthalide with *o*-phenylenediamine the following products were obtained: (1) Benziminazole-2-benzyl*ortho*phenylene diamine (III), (2) *o*-aminophenyl-*o*-aminophenyl aminomethyl benzamide and (3) *o*-aminophenyl-*o*-oxymethyl benzamide (IV). Condensation between *o*-methoxy benzoic acid and *o*-phenylene diamine gave compounds (III), (IV) and *o*-aminophenyl-ammonium -*o*-oxymethyl-benzoate.

On dehydration compound (IV) changed into a product which crystallises in colourless rosettes, m.p. 185°. The synthesis itself establishes the constitution of the product as *o*-benzylene—1 : 3—benziminazole (II). Thiele and Falk's compound, (m.p. 213·5°C and not 210°C as mentioned by them) must therefore be an isomeric one and identical with benzylyl-*o*-phenylene diamine (I).

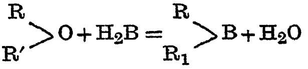
Similar condensation between phthalide and ethylene diamine gave *ortho*benzylene-dihydroiminazole which on oxidation was converted into *ortho*benzoylenedihydroiminazole.

Other condensations between ethylenediamine and phthalic and naththalic anhydrides, and also between maleic anhydride and *o*-phenylene-diamine have been carried out.

48. Studies in catalytic dehydration.

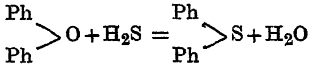
M. Goswami *and* Manindra Nath Sanyal, Calcutta.

Catalytic dehydration over thoria, in which ethers like diphenyl oxide, anisol, amyl, butyl. propyl, and ethyl ethers take part when ammonia, aniline, or sulphuretted hydrogen is passed with them has been studied. It was expected that the general reaction



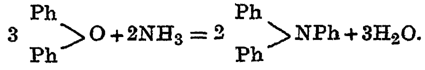
$$\genfrac{}{}{0pt}{}{R}{R'}\!>O+H_2B=\genfrac{}{}{0pt}{}{R}{R_1}\!>B+H_2O$$

where R and R′ are radicals and B stands for S, NH, and NPh would take place. It appears that with diphenyl oxide and sulphuretted hydrogen the reaction,



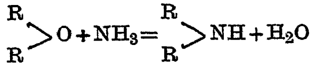
$$\genfrac{}{}{0pt}{}{Ph}{Ph}\!>O+H_2S=\genfrac{}{}{0pt}{}{Ph}{Ph}\!>S+H_2O$$

is normal but when the acid hydride is replaced by NH_3 and $PhNH_2$ abnormal behaviour occurs; the general reaction is extremely sluggish and only there is slight formation of tertiary amine due perhaps to the following reaction :—



$$3\genfrac{}{}{0pt}{}{Ph}{Ph}\!>O+2NH_3=2\genfrac{}{}{0pt}{}{Ph}{Ph}\!>NPh+3H_2O.$$

but there is abundant formation of fine crystalline needles in the receiver. These crystals after being filtered and washed with absolute alcohol were examined when it was found that they soften near 85° with evolution of ammonia and leave a residue of thorium oxide when heated on a nickel spatula. The products are still under investigation. Similar types of compounds have been obtained with anisol, but with ethyl, propyl, butyl, and amyl ethers there is no such formation and on the other hand appreciable amounts of secondary amine according to equation



$$\genfrac{}{}{0pt}{}{R}{R}\!>O+NH_3=\genfrac{}{}{0pt}{}{R}{R}\!>NH+H_2O$$

are formed.

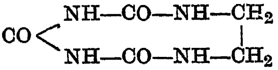
We propose to examine whether such differences in the reaction are attributable to the basic character of oxygen as modified by the attached radicals positive or negative.

49. On Uric Acid.

M. N. Ramaswamy *and* P. C. Guha, Bangalore.

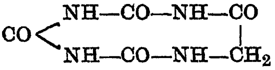
The present paper is a continuation of previous work (Proc. Ind. Sc. Congress, 1929).

Carbo-ethylenediurea



has been obtained as one of the products of interaction between ethylene diamine and carbo-diurethane. On dehydrating this with boiling strong hydrochloric acid, a compound is obtained which shows the characteristic properties of purines, and appears to be desoxyuric acid.

The carbonyl analogue of carbo-ethylene-diurea, namely



has been built up by a series of reactions starting from glycine ester hydrochloride. Attempts are being made to dehydrate this compound. Such dehydration it is expected would result in the formation of uric acid.

50. An Improved Method of preparation of substituted Amides and Hydrazides.

S. M. Mistry *and* P. C. Guha, Bangalore.

Amides like urea, oxamide, malonamide, succinamide, acetamide, etc. react with aromatic amines and hydrazines in presence of boiling *iso*-amyl alcohol to yield the corresponding substituted amides and hydrazides. In most cases crystalline products are obtained in almost quantitative yield which do not require further purification. Aromatic amides, *o*-nitro-substituted aromatic amines and hydrazines do not react. This generalisation is based on the results gathered from about 50 such reactions.

51. Researches on the preparation of Aromatic Distibinic Acids.

S. M. Mistry *and* P. C. Guha, Bangalore.

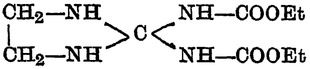
Sym-diaminodiphenyl urea on diazotisation and coupling with antimony trichloride gives a compound which on treatment with alkali is converted into a compound to which the probable formula $PhNH.CO.NH.C_6H_4SbO_3H_2$ is suggested. This conclusion has been arrived at from similarity of properties and identical results of analysis of the compound obtained from $PhNH.CO.C_6H_4NH_2$ by diazotisation, coupling and alkali treatment.

The corresponding compound obtained from benzidin appears to be the anhydride of diphenyl-distibinic acid. *p*-Carbamido-phenyl stibinic acid ($NH_2CO.NH.C_6H_4.SbO_3H_2$) and *p*-amino-phenyl stibinic acid on being condensed with urea in presence of boiling amyl alcohol give the anhydrides of the compounds whose probable formulæ would be $CO.(NH.CO.NH.C_6H_4SbO_3H_2)_2$ and $CO\ (NH.C_6H_4SbO_3H_2)_2$ respectively.

52. A derivative of Tetra-aminomethane.

M. N. Ramaswamy *and* P. C. Guha, Bangalore.

When studying the action of ethylene diamine on carbo-diurethane, a compound was obtained, which in the light of the available experimental evidence, is most completely represented by the structure.



53. Methyl *cyclo*hexane-2 : 3-dione-1 : 4-dicarboxylate.

P. P. Patel *and* P. C. Guha, Bangalore.

The preparation was attempted by condensing methyl oxalate with methyl adipate. Contrary to the observations that oxalic ester has no ring-forming action on ethyl adipate or ethyl succinate (Wislicenus and Schwanhausser, Ann. **297**, 98), the condensation with adipic ester gives the expected diketone, m.p. 112–113^c (mono-semicarbazone, m.p. 170^c, violet coloration with ferric chloride), though in a poor yield, together with methyl oxalo-adipate, methyl *cyclo*-pentanone-2-carboxylate and probably ethyl carbonate. While the work to improve the yield of the diketone by employing varying conditions was in progress a paper by L. Dedusenko appeared in the British Chemical Abstracts (1929, May, 558) wherein a mention of the ethyl analogue of our compound has been made. An alternative method to obtain the same diketone starting from the disodium derivative of $\alpha\alpha\delta\delta$-butane-tetracarboxylic ester and oxalyl chloride is also being tried.

54. Condensation of Semicarbazide with Anhydrides of Dibasic Acids.

Bani Kanta Banerjee, Rajshahi.

When acted upon in molecular proportions, phthalic anhydride produces a monophthalyl derivative of semicarbazide in alcoholic solution,

$$C_6H_4(CO)_2N\text{-}NH\text{-}CO\text{-}NH_2$$

The monophthalyl derivative again condenses with another molecule of phthalic anhydride yielding a diphthalyl derivative,

$$C_6H_4(CO)_2N\text{-}NH\text{-}CO\text{-}N\ (CO)_2C_6H_4$$

In the case of camphoric and diphenic anhydrides, dicamphoryl and didiphenyl semicarbazides only could be obtained. The presence of the free amino group in the monophthalyl compound has been confirmed by condensation with (1) benzaldehyde, salicyladehyde, and (2) another molecule of phthalic anhydride.

55. Heterocyclic derivatives of terpenes and camphors.

Hari Dev, Ram Bahadur, *and* J. N. Ray, Lahore.

Condensation of hydroxy methylene camphor and menthone with substances like hydrazine gives rise to heterocyclic compounds with bi-and tri-cylic ring-systems.

56. Polynuclear heterocyclic types, derivatives of pentamethine.

G. C. Singh *and* J. N. Ray, Lahore.

Condensation of hydrindones with nitro-aldehydes gives nitroalkylidene hydrindones which on reduction pass to indeno-quinolines. On mild oxidation these are converted into pentamethine derivatives of quinoline.

57. On brazilin.

(Late) W. H. Perkin, R. Robinson *and* J. N. Ray, Lahore.

Catalytic reduction of synthetic hydroxytrimethyl brazilin.

58. On the relationship between hydrastine and berberine.

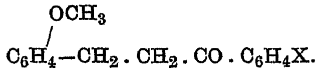
J. N. Ray, Lahore.

Certain intermediate compounds in the synthesis of berberine (Perkin, Ray, and Robinson) on methylation and reduction pass into optically inactive hydrastine. The resolution and isolation of optically pure hydrastine is complicated by the fact that an unusually large number of isomers are obtained, the exact stereochemical relation of which is not yet understood. But nevertheless, their synthesis affords a conclusive evidence for the structure of hydrastine and incidentally establishes its relationship with berberine.

59. Synthesis in the Catechin Series.

J. N. Ray *and* Students, Lahore.

Coumarins on methylation give *o*-methoxycinnamic acids. These on reduction are converted into corresponding hydrocinnamic acids. The esters of these acids condense with phenols and phenolic ethers in presence of 80% H_2SO_4 to give



$$\overset{OCH_3}{C_6H_4}-CH_2\,.\,CH_2\,.\,CO\,.\,C_6H_4X.$$

These on treatment with HI pass to flavanes which are analogous to cyano-maclurin and catechin in constitution.

60. Phthalazines. Part II —Analogoues of papaverine.

J. N. Ray *and* Others, Lahore.

Extension of the work of Aggarwal, Darbari, and Ray, (J.C.S., 1929, October) to the phenyl acetic hydrazides leads to the production of bodies analogous to papaverine in structure.

61. *N*-Methyl*iso*pelletierine.

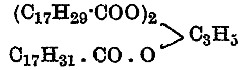
J. N. Ray *and* Students, Lahore.

Benzoylpiperidine gives on oxidation benzoylaminovaleric acid, the chloride of which, on treatment with zinc propyl iodide gives the corresponding ketone. The *iso*-nitroso derivative of this undergoes ring closure on hydrolysis forming a substance which is believed to be racemic modification of the above.

62. Studies in the isomerism of the higher unsaturated fatty acids and their derivatives. Part I. Bromination of drying oils.

P. Ramaswami Ayyar *and* V. A. Patwardhan, Bangalore.

The oils from the seeds of *Holarrhena antidysenterica* and *Ocimum basilicum* in ethereal or ethyl acetate solution yield on saturation with bromine, in the cold, a crystalline precipitate of a brominated glyceride (m.p. after crystallisation from ethyl acetate 156–157°) which analyses correctly for a dilinoleno-linolin of the structural formula



$$\left.\begin{array}{l}(C_{17}H_{29}\cdot COO)_2\\ C_{17}H_{31}\,.\,CO\,.\,O\end{array}\right> C_3H_5$$

The bromination of the free acids and their methyl esters is being studied.

63. Studies in the synthesis of higher fatty acids by the action of organometallic compounds on derivatives of dibasic acids. Part III.

P. Ramaswami Ayyar *and* V. A. Patwardhan, Bangalore.

The action of zinc-propyl-iodide and zinc-*iso*butyl-iodide on 11-bromo-undecylic acid results in the production of a mixture of undecylic and undecylenic acids.

Magnesium methyl iodide gives with methyl azelate 9-methyl-9-hydroxy decylic acid, and the ditertiary glycol (m.p. 67° C).

Magnesium heptyl iodide reacts with succinic anhydride to give 4-ketoundecylic acid (m.p.=80°-80·5° C; semicarbazone, 132°–133° C), along with formation of a hydrocarbon, $C_{14}H_{30}$.

64. On some derivatives of 4-phenylcoumarin. Part II.

P. C. Mitter *and* P. K. Paul, Calcutta.

7-Methoxy-4-phenylcoumarin (Proc. Indian Sc. Congress, 1929) gives on reduction with sodium and alcohol, 2-oxy-4-methoxy-ββ diphenyl propyl alcohol (m.p. 77°–78°). On heating an alcoholic solution of the substance saturated with hydrochloric acid at 100° for six hours, in a sealed tube, 7-methoxy-4-phenylchroman (b.p. 203–204° 10 mm.) is obtained.

2 : 4 : 3′ : 4′—Tetramethoxybenzophenone (from veratroyl chloride and resorcin dimethyl ether, in presence of aluminium chloride) is condensed with bromacetic ester in presence of zinc. On distilling the product under diminished pressure and hydrolysing the distillate, 2 : 4 : 3′ : 4′—tetramethoxy-ββ-diphenylacrylic acid (m.p. 157°) is obtained.

On reduction with sodium amalgam, this gives 2 : 4 : 3′ : 4′—tetramethoxy-ββ-diphenyl propionic acid (m.p. 121°).

Treatment with glacial acetic acid and acetyl chloride converts the acrylic acid derivative into 7 methoxy 4-(3′ : 4′ dimethoxy) phenylcoumarin (needles from alcohol, m.p. 163°).

An alternative method of preparing the substance is by the condensation of veratroyl acetic ester with resorcin monomethyl ether in presence of sulphuric acid.

7-Hydroxy-4-(3′ : 4′-dimethoxy) phenylchroman is obtained by condensing resorcin with veratroyl acetic ester in a similar manner (m.p. 236°). Methylation with dimethyl sulphate and alkali gives 7-methoxy-4-(3′ : 4′—dimethoxy) phenylchroman described above.

The work is being continued.

65. Synthesis of Dihydroxychrysazin.

S. V. PUNTAMBEKAR, Bangalore.

Hemipinic anhydride was condensed with *o*-chlorophenol in the presence of anhydrous aluminium chloride. The ring closure of the resulting benzoyl-benzoic acid (m.p. 253°) was achieved by concentrated sulphuric acid at 140°. The product, presumably 1 : 2-dimethoxy-7-chloro-8-hydroxy-anthraquinone, showed the characteristic tests of an hydroxy-anthraquinone. Replacement of the chloro- and the methoxy-groups by hydroxyl groups yielded an anthraquinone, presumably the dihydroxy-chrysazin. It crystallised from alcohol in long dark-red needles (m.p. 323°) and gave purple and red solutions with sodium hydroxide and concentrated sulphuric acid respectively.

66. Studies in the anthraquinone series : On 1-oxy-6-methyl- and 2-oxy-6-methylanthraquinones.

P. C. MITTER *and* ASOKE KUMAR SIRCAR, Calcutta.

3-Nitrophthalic anhydride condenses with toluene in presence of aluminium chloride giving 3-nitro-2-*p*-toluoyl benzoic acid which gives 3-amino-2-*p*-toluoylbenzoic acid on reduction. This on diazotisation gives 3-oxy-2-*p*-toluoyl benzoic acid from which by the action of sulphuric acid 1-oxy-6-methylanthraquinone is obtained.

Similarly, starting from 4-nitrophthalic anhydride and toluene, 2 : oxy-6-methylanthraquinone is obtained. This on alkali fusion gives 1-2-dioxy-6 methylanthraquinone, and on methylation 2-methoxy-6-methylanthraquinone. On nitration, this latter gives a dinitro-derivative.

67. Nitration of 2-oxy-3-methylanthraquinone.

P. C. MITTER *and* SUDHIR CHANDRA PAL, Calcutta.

Nitration of 2-oxy-3-methylanthraquinone according to the method of Eder and Manoukian (Helv. Chim. A. 1926, 9, 54) gives 1-nitro-2-oxy-3-methylanthraquinone from which on methylation 1-nitro-2-methoxy-3-methylanthraquinone is obtained. On treating with potassium methoxide this substance is converted into 3-methyl alizarin dimethyl ether, which may be de-methylated to 3-methyl alizarin. This latter gives on oxidation 3-methylpurpurin which on reduction with stannous chloride in alkaline solution gives rubiadin.

68. Munjisthin. Part II.

P. C. MITTER *and* HARAGOPAL BISWAS, Calcutta.

Although there are numerous indications pointing to munjisthin being 2 : 4-dioxy-3-carboxyanthraquinone its formation by direct oxidation of rubiadin is rendered difficult by the presence of the two -OH groups in *o*-position to the methyl group. An indirect method of oxidation is therefore being attempted.

2 : 6-Dinitrotoluene is reduced with ammonium sulphide to 2-nitro-6-aminotoluene which is converted into 2-nitro-6-oxytoluene over the diazo salt. This is methylated and the 2-nitro-6-methoxy toluene reduced by stannous chloride to 2-amino-6-methoxy toluene, which is converted into

2-oxy-6-methoxy toluene over the diazo compound and methylated. 2 : 6-Dimethoxytoluene, thus obtained is condensed with phthalic anhydride in presence of aluminium chloride giving 2-(2′ : 6′-dimethoxy)-*p*-toluoyl benzoic acid. Attempts are being made to convert the methyl group into a carboxyl group, to be followed by ring closing and demethylation.

69. The Constitution of "Alkanin" the red colouring matter from Alkanet. Part I.

M. V. Betrabet *and* G. C. Chakravarti, Bangalore.

Alkanin has been obtained in a pure form m.p. 220° (decomp.) by a long series of purification experiments, from the crude petroleum (p. 50–60°C) extract of the powdered roots of alkanet. It gives an indigo blue colour to alkaline solution and purple red to concentrated sulphuric acid. It is soluble in most solvents. It is insoluble in sodium bicarbonate and its chloroform solution does not give precipitates with lead acetate or ferric chloride solutions. Combustion results and molecular weight determinations seem to indicate a formula $C_{30}H_{28}O_8$. It gives tetra-acetyl, dimethoxy, pentabromo- and tetra-acetyltribromo derivatives. Oxidation with fuming nitric acid gives a nitro-compound and oxalic acid. Nitric acid (*d* 1.2) gives a nitro-compound, succinic acid, oxalic acid, and a neutral compound. Hydrogen peroxide has no effect. Oxidations of the acetyl alkanin and alkanin with permanganate and chromic acid are in progress.

Liebermann and Romer (Ber. 1887, **20**, 2428) mention to have obtained anthracene and methyl anthracene by zinc dust distillation.

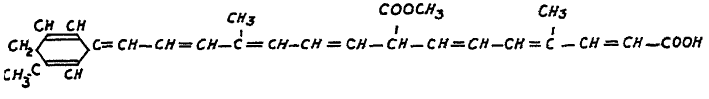
70. The Constitution of Bixin.

K. Venkataraman.

While bixin is known to contain 9 double bonds, it was found that with palladium-barium sulphate as catalyst and glacial acetic acid as solvent only 14 atoms of hydrogen were absorbed. On esterification of the product and bromination, 4 atoms of bromine were taken up. Carrying out the reduction with ethyl acetate as solvent, 18 atoms of hydrogen were readily absorbed.

Attempts are being made to replace the bromine in bixin decabromide by hydrogen and oxidise the product.

The purely aliphatic structure suggested for bixin by Kuhn and Winterstein and the fulvene structure suggested by Faltis and Viebock are criticised. The deep colour of bixin, the formation of *m*-ethyl toluene by zinc dust distillation, the production of one molecule of *m*-xylene from one molecule of bixin and the necessity for the wandering of a double bond in the explanation of the existence of bixin, *iso*bixin and *β*-bixin are facts difficult to account for on the basis of Kuhn's structure. The following structure is in agreement with all the known evidence :—


CH CH
CH₂
CH₃C CH
C= CH—CH = CH—C = CH—CH = CH—CH—CH = CH—CH = C —CH = CH—COOH
CH₃
COOCH₃
CH₃

The quinone structure and the conjugated ethylenic linkages account for the colour, and the production of one molecule of *m*-xylene by reduction; the ozonisation results of van Hasselt and the isomerism of bixin, *β*-bixin and *iso*bixin are all explicable. While bixin cannot be esterified in the usual way, methyl bixin may be obtained by the action of diazomethane (Herzig and Faltis); partial hydrolysis of methyl bixin leads to *iso*bixin and not to bixin. The carboxyl and carbomethoxyl are thus unsymmetrically attached in the bixin molecule.

71. Alkaloids of *Hedyotis Auricularia*, Linn.

BIMAN BIHARI DEY, Madras.

A general examination of this plant showed that it contained considerable amount of tannin, some reducing sugars and glucosides with one or more accompanying enzymes which caused fermentation with evolution of CO_2, a small quantity of a fixed oil, a fruity-smelling ester, and a basic principle precipitated by the common alkaloidal re-agents. The latter is found to occur in all parts of the plant, the roots containing the largest amounts. An assay of the alkaloids (*a*) in the leaves and stems, and (*b*) in the roots, showed that the former contained 0·1%, and the latter 0·3% approximately. The air-dried, powdered roots which were selected for detailed examination, gave to petroleum ether (b.p. 60°–70°) 1·1%, ether 2·6%, alcohol 8·9%, and water 7·7% extracts respectively. The alcoholic extract was found to contain the whole of the alkaloids.

The alkaloids were purified through their mercuri-chlorides. A sparingly soluble hydrochloride separating from methyl alcohol and ether in nearly colourless, hard prismatic crystals, sintering at 235°C, and melting with decomposition at 258°C, and a soluble hydrochloride which did not crystallise, but remained as a pale yellow thick syrup, have been isolated. As a mean of three closely agreeing estimations, the chlorine in the former was found to be 10·3%; assuming the salt to contain only 1 molecule of HCl, the molecular weight of the alkaloid hydrochloride should approximate to 343. The hydrochlorides dissolved in water as well as alcohol, with a bright bluish-green fluorescence.

Both the sparingly soluble, and the soluble hydrochlorides, on treatment with cold dilute caustic alkalis, precipitated the alkaloid or alkaloids as a fine golden yellow powder. The latter looked pure, and remained unchanged when kept under water for weeks. On filtering and attempting to dry it, however, it rapidly changed to a dark brown sticky mass from which the original hydrochlorides could not be reproduced. The change appears to be one of oxidation, and the reaction is being studied more closely.

The picrate corresponding to the alkaloid of the sparingly soluble hydrochloride, separated in well-formed, deep yellow crystals of a pyramidal structure, melting with effervescence at 264°C ($N = 15·9\%$).

72. Constitution of the active principle of *Corchorus Capsularis.*

NIRMAL KUMAR SEN, Dacca.

Corchorin, the active principle of jute-seeds has been obtained in colourless prisms, melting and decomposing at 174–175°C. It is a glucoside having an extremely bitter taste and has saponin-like properties but unlike saponin it has no hemolytic action on red blood corpuscles. It is dextrorotatory $[\alpha]_D = 33·4$ and has the molecular formula $C_{22}H_{36}O_8$ [mol. wt.=423, 427 in glacial acetic acid and 435 and 439 in phenol (Raoult)]. It gives an acetyl derivative m.p. 83–85°C, and with bromine yields the crystalline monobromo-corchorin-dibromide, m.p. 100°C. On hydrolysis by mineral acids it yields glucose and a yellow product having the composition $C_{16}H_{26}O_3$ which forms rhombic plates melting and decomposing at 114–115°C and it has been termed "corchogenin". Corchogenin contains a double bond since it readily gives a crystalline dibromo-derivative and contains no methoxy group. It reduces ammoniacal silver nitrate in alcoholic solution and on prolonged heating with phenylhydrazine gives an amorphous hydrazone. It yields a trichloro-derivative ($C_{16}H_{23}Cl_3$) when heated with PCl_5, m.p. 124-125°C. On oxidation with potassium permanganate, corchorin yields a crystalline acid, m.p. 57–60°C, having a mean molecular weight 456·5, which on hydrolysis yields an acid nad glucose.

73. Morellin—a Yellow Crystalline Colouring Matter in the Pericarp of the Seeds of *Garcinia Morella*, Desr.

B. Sanjiva Rao, Bangalore.

The colouring matter $C_{30}H_{34}O_6$ is obtained in a yield of 1·6 per cent. by extraction of the seeds with methyl alcohol and melted at 153–154°. During its investigation, the following derivatives have been prepared and described: acetyl derivatives ($C_{38}H_{42}O_{10}$, m.p. 178–179°), bromoderivative ($C_{30}H_{34}O_6Br_4$, m.p. 138–139) oxime ($C_{30}H_{36}O_6N_2$ m.p. 148–149°) phenylhydrazone, (m.p. 258°), *p* nitro-phenylhydrazone (m.p. 201–202°) and the methoxy derivative (m.p. 101–102°).

74. Chemical examination of Fenugreek (*Trigonellum foenum Graecum*).

M. Sreenivasaya *and* B. N. Sastri, Bangalore.

Ether extracts a semi-drying oil with the characteristic pungent odour. Seventy per cent. alcohol extracts phospholipins which get precipitated by an alcoholic solution of cadmium chloride. On addition of acetone a white amorphous body separates which is hygroscopic, optically active (dextro), contains nitrogen and phosphorus in stochiometric ratio of 3 : 1 and on acid hydrolysis liberates a reducing sugar. Further work is in progress.

75. Chemical examination of the roots of *Bragantia Wallichii* (Br.).

B. L. Manjunath *and* D. V. Venkatasubbaiya, Bangalore.

Bragantia Wallichii belongs to the family of *Aristolochiaceac*, (Sams. *Chakrani*). The root in the form of a paste is used in medicine. The material for the following work was collected in Shimoga district (Mysore State).

Successive extraction with the following solvents.	Per cent. of extract.
Petroleum ether (b.p. 40—50°)	0·5
Ethyl ether	3·2 (fluorescent solution)
Chloroform	0·6 (,, ,,)
Ethyl acetate	0·6
Alcohol	4·4
Total	9·3

The occurrence of an alkaloid has been established. The constituents (volatile in steam) amounted to 0·01 %. An aqueous extract of the roots gave tests for starch and reducing sugars. No tannin material could be detected.

The paper deals with the chemical and pharmacological study of the various constituents.

76. Chemical examination of the seeds of *Cassia Tora* (Linn.).

H. S. Jois *and* B. L. Manjunath, Bangalore.

The occurrence of the glucoside of a substance of the nature of emodin in the seeds of *Cassia tora* has been recorded in the literature. The following work is a more detailed study of the various constituents of the seeds.

Successive extraction with the following solvents.	Per cent. of extract.
Petroleum ether (b.p. 40 – 50°)	5·2
Ethyl ether	1·2
Chloroform	1·6
Ethyl acetate	2·2
Alcohol	6·2
Total	16·4

Constituents volatile with steam=0·003% (pale yellow crystals).

The petroleum ether extract gave a pale brown oil which had the following constants :—

Sp. gravity at 25°/25°	0·8969
Refractive index at 25°	1·4743
Saponification value	154·2
Iodine value (Hanus)	90·7

A more detailed study of the oil particularly because of its medicinal value in skin diseases, will form the subject of another communication.

Ethyl ether extracted a small amount of the colouring matter occurring in the free state. The glucoside was obtained mainly in the ethyl acetate and alcohol extracts. The seeds did not contain any alkaloids. The presence of an enzyme has been established. An aqueous extract gave tests for reducing sugars as well as for hydrolysable polysaccharides. Starch and tannin were absent.

77. Chemical examination of the seeds of *Psoralea Corylifolia* (Linn.).

B. L. Manjunath, Bangalore.

The seeds of *Psoralea corylifolia* (*Bhavancha* in Samskrit) are used in Ayurvedic medicine. The present investigation forms a systematic analysis of the various substances present in the seeds.

Successive extraction with the following solvents.	Per cent. of extract.
Petroleum ether (b.p. 40—50°)	8·0
Ethyl ether	10·8
Chloroform	3·7
Ethyl acetate	3·2
Alcohol	8·2
Total	33·9

The percentage of the essential oil was found to vary.

The petroleum ether extract gave a dark brown viscous oil which had the following constants :

Sp. gravity at 25°/25°	0·9689
Refractive index at 25°	1·5137
Saponification value	133·2
Iodine value (Hanus)	113·3

The oil is being investigated further.

The ether extract contained the entire colouring matter. The seeds did not contain any alkaloidal constituents. An aqueous extract gave tests for the presence of a small amount of reducing sugars, and for a considerable amount of hydrolysable polysaccharides. Starch and tannin were absent.

78. Proximate Analysis of *Coscinium Fenestratum*, Coleb.

M. C. TUMMIN KATTI *and* (the late) V. P. SHINTRE,
Bangalore.

The alcoholic extract of the stems of the plant has been found to contain the following compounds.

Palmitic acid, a hydrocarbon (m.p. 68–69°), phytosterolin (sitosterol-glucoside), sitosterol (m.p. 135–136°), ceryl alcohol (m.p. 78–79°), saponin, glucose, and a considerable amount of a mixture of alkaloids.

79. Chemical Examination of the Bark of *Terminalia Arjun.*

A. JANAKI RAM *and* P. C. GUHA, Bangalore.

The present work describes the isolation of two organic acids and a phytosterol in addition to confirming the presence of tannins and colouring matters.

80. Cantharidin from *Zonabris* (*Mylabris*) *Pustulata,* (Indian).

B. H. IYER *and* P. C. GUHA, Bangalore.

Zonabris (*Mylabris*) *pustulata,* commonly known as blister-beetles were collected locally and examined for the cantharidin content. A method of extraction has been found out which given an yield of 2·1 2·3% of cantharidin. About 0·5 to 0·6 % is found to exist in the salt-form, the remainder being present as free cantharidin. The dried insects yield 12 to 12·5% fat.

Synthesis of deoxycantharidin is being effected starting from *o*-methyl*cyclo*hexanone. After obtaining 1 : 2—dibromo—1 : 2—dimethyl-*cyclo*hexane, its dinitrile is prepared. It is expected that the dinitrile will give the dicarboxylic acid and the corresponding anhydride, the latter of which will be deoxycantharidin.

81. Oil from cantharides insects.

B. H. IYER *and* P. RAMASWAMI AYYAR, Bangalore.

This oil obtained as a by-product in the isolation of cantharidin from the insects had a sp. gr. 30°/24° of 0.910, after neutralisation and removal of admixed cantharidin.

The crude fatty acids have an I.V. of 42·6, and an equivalent weight of 220. When analysed by the lead-salt-alcohol method they gave 31 per cent. of saturated acids and 69 per cent. of unsaturated acids. The former have an equivalent weight of 260 and the latter seems to be a mixture of oleic and a small quantity of cantharidic acids.

82. Oil from the seeds of *Ocimum Basilicum* (Linn.).

P. RAMASWAMI AYYAR *and* V. A. PATWARDHAN, Bangalore.

The seeds yield to petroleum ether 9·5 per cent. of oil, which has been characterised by the following properties:

Sp. gr. at 25°C = 0·933
Ref. index at 25°C = 1·48
Iod. value = 166·6
Sap. value = 191·8
Acetyl value = 16·5
Unsaponifiable matter = 1·2

The fatty acids have been resolved by Twitchell's method into saturated (7·4 per cent.) and unsaturated (92·6 per cent.) acids. The former consists mostly of palmitic acid mixed with a small quantity of stearic acid.

The latter are composed of two isomeric linolenic acids, linolic acid and oleic acid.

The sterol obtained from the unsaponifiable matter melts at 115–120°C.

83. Oil from the seeds of *Schleichera Trijuga*, Willd.

P. RAMASWAMI AYYAR *and* S. M. PATEL, Bangalore.

A genuine specimen of the expressed oil obtained from Palghat had the following physical and chemical characteristics:

Sp. gr. at 15°C = 0·918
Ref. index at 25°C = 1·466
Sap. value = 223·0
Iod. value = 52·8
Unsaponifiable matter = 3·7

The fatty acids were resolved by the lead-salt-alcohol method into saturated (43 per cent.) and unsaturated (57 per cent.) acids. The former are composed mostly of palmitic (18 per cent.) and *n*-eicosanic acids (82 per cent.) The latter consists mainly of oleic acid.

From the unsaponifiable matter pure sitosterol has been isolated.

84. Oil from the seeds of *Amoora Rohituka.*

P. RAMASWAMI AYYAR *and* V. A. PATWARDHAN, Bangalore.

The kernels (78% of the seeds) yield to petroleum ether 45% of a fixed oil, and the cake yields to alcohol about 1% of a solid resin. The oil has the following properties:

Sp. gr. at 15°C = 0·931
Ref. index at 25°C = 1·480
Saponification value = 186·0
Iod. value = 130·0

The oil does not yield a crystalline bromoglyceride on bromination and resembles poppy seed oil in this respect.

85. The constituents of the Essential Oil from the leaves of *Cinnamomum Zeylanicum*, Breyn: The occurrence of γ-terpineol.

(The late) V. P. SHINTRE *and* B. SANJIVA RAO, Bangalore.

The leaves obtained from the Western ghats yielded 0·2 per cent. of an oil. The authors have isolated the following:—*l*-α-pinene, β-phellandrene (3.5 per cent.) eugenol (15 per cent.) terpene alcohols mainly γ-terpineol (2.1 per cent.) sesquiterpenes mainly *l*-cargophyllene (62 per cent.) sesquiterpene alcohols (6.8 per cent.)

86. The Essential Oil from the Flower-heads and stems of *Andropogon Kuntzeanus*, Hack, *Forma Foveolata*, Hack.

B. SANJIVA RAO, Bangalore.

The oil was obtained in a yield of 0·27 per cent. and consisted of terpenes (30 per cent.) *l*-α-pinene, *l*-camphene, *l*-limonene, *l*-borneol, sesquiterpenes (4 per cent) sesquiterpene alcohols (61 per cent.).

87. Examination of unsaturated acids in fish oil.

J. K. Chaudhury *and* P. B. Sarkar, Dacca.

The stomach oil of "Labeo rohita"—an Indian fresh-water fish commonly known in Bengal as 'Rohit'—was found to consist of 28·1% saturated acids (I.V. 2·4) and 71·9% of unsaturated acids (I.V. 180·8). The unsaturated acids were (1) oxidised with very dilute potas. permanganate at 0°, and (2) brominated at –10° in dry ethereal solution. The oxidation method revealed the presence of *asellinic* and *oleic acids* while the bromination method confirmed the following acids which were also quantitatively determined:—*Tetrosapentenoic acid*, *Linolenic acid*, and *Hexadecatrienoic acid.*

Hexadecatrienoic acid (having 16 atoms of carbon and 3 double bonds) whose presence in fish oil was suspected by Brown and Beal, has been isolated (as hexabromide) and examined by the authors for the first time while tetrosapentenoic acid has not been found in any fish oil before. The only experimental evidence of the existence of this latter acid is found in the work of Carter (J.S.C.I., 1928 **47**, 31T,) who found it in mutton bird oil. The bromo-derivative of Carter, however, blackened at a much lower temperature (200°) than ours (242°).

It may be noted that the separation of the polybromides could not be effected by the usual method but only with the help of chloroform which has been found very suitable for the purpose. The detection of asellinic acid having an odd number of carbon atoms, whose existence has been doubted by several investigators, confirms the work of Fahrion (Chem. Umsch., 1927 **24**, 6,).

88. Chemical and Physico-chemical Examination of *Eupatorium Ayapan* and *Justicia Gandharussa.*

N. C. Nag *and* K. Bose, Calcutta.

The two plants are important medicinal plants with distinctive physiological actions, which are likely to be associated with certain definite chemical constituents. The plants have been grown at the Bose Institute at Calcutta and also at Falta, 30 miles down the Ganges. Changes in the amounts of chemical constituents under varying conditions of locality and of seasons have been studied.

Pressed out sap of *Eupatorium Ayapan* is distinctly acidic, pH value ranging between 6.07 and 5.75 (the higher values are obtained during the rains). Refractive index at 30° for the two varieties examined on the same day was found to lie between 1.3432 and 1.3462.

Of *Justicia Gandharussa* there are two varieties, one purple and the other green twig variety. The purple variety is very rich in chlorine and total nitrogen as also in nitrate content. There is however-great variation with the season changes, chlorides (and to some extent the nitrates) coming to almost half the dry season values.

The pH value of sap from purple variety lay between 7.86 and 7.68 with a tendency towards neutrality during the rains. Refractive index was 1.3425.

Green variety of *Justicia Gandharussa* had low nitrogen content. Green *Justicia Gandharussa* sap was alkaline but the pH value was nearer 7.01, thereby verging on acidity, thus standing intermediate between purple *Gandharussa* and *Eupatorium Ayapan* during the rains.

A quantitative study of the following constituents were made, both in the ash and in the dry matter obtained from the plants:—

Moisture, ash, SiO_2, P_2O_5, Cl, NO_3, total N, SO_3, Fe, CaO, MgO, Na, K, fibre, sugar convertible carbohydrates, etc., (suitable methods had to be devised in some cases).

89. Alkaloids in *Diospyros Cardifolia.*

MOHD. RAFAT HUSAIN SIDDIQI *and* Q. A. MANSURI, Aligarh.

The dried and powdered fruits were extracted with lime and water. The colouring matters, etc., were removed by means of lead acetate and lead by means of sulphurreted hydrogen. The filtrate was concentrated and tested with the alkaloidal re-agents which indicated the presence of alkaloids. Further work is in progress.

90. Preliminary Examination of the Constituents of *Hydro cotyle Asiatica.*

M. A. WALI *and* TUMMIN KATTI, Bangalore.

Seven crystalline substances were isolated but the quantities were too small to be identified. Presence of reducing sugars and a phytosterol, b.p. 120°–122° was indicated.

91. Investigation of *Aristolochiæ Indica.*

M. A. WALI, Bangalore.

Aristolochiæ Indica was found to contain an alkaloid.

92. Halogenation. Part IV.—Halogenation of Aromatic Acids.

P. S. VARMA *and* P. B. PANICKER, Benares.

A good yield of *m*-bromobenzoic acid has been obtained by brominating benzoic acid in presence of a mixture of fuming nitric and nitrosulphonic acids, or sodium nitrite and fuming sulphuric acid. Iodobenzoic acid is also obtained comparatively in good yield in presence of the same re-agents. With *p*- and *o*-toluic acids, mono-bromo-, and mono-idoderivatives have been obtained. *m*-Toluic acid is not brominated or iodinated under the same conditions. Anisic acid gives bromo- and iododerivatives whilst phthalic, *iso*phthalic and terephthalic acids are unaffected. *p*-Nitro, *p*-chloro-, and *p*-bromo-benzoic acids are also not halogenated.

93. Halogenation. Part V.—Halogenation of Naphthalene, β-Naphthylamine and β-Naphthol.

P. S. VARMA *and* D. N. MAZUMDAR, Benares.

Attempts have been made to iodinate naphthalene directly under different conditions in presence of a number of substances, such as pyridine, concentrated nitric acid, fuming nitric acid nitro-sulphonic acid, potassium persulphate, chromic acid, fuming sulphuric acid, a mixture of fuming nitric and sulphuric acid, and iodic acid. Iodonaphthalene has been obtained in most cases. β-Naphthylamine has resisted up till now all attempts of iodination. β-Naphthol is, however, iodinated and an iododerivative of it has been obtained in a comparatively good yield in presence of ammonia.

Naphthalene is more easily brominated in presence of nitro-sulphonic and fuming nitric acid mixture.

94. Halogenation. Part VI.—Bromination and Iodination of Anthraquinone.

P. S. VARMA *and* A. SUBRAMANYAM, Benares.

Anthraquinone has been brominated and iodinated in presence of a few foreign substances, and mono-bromo-, dibromo-, mono-iodo-, and di-iodo—anthraquinones have been obtained in fairly good yields.

95. Halogenation. Part VII.—Replacement of Sulphonic Groups in Aromatic Amino-sulphonic Acids by Halogens.

P. S. VARMA *and* G. SANYASAYYA, Benares.

The action of halogens on the sulphonic acid derivatives of mono-methyl-, di-methyl , mono-ethyl-, and di-ethyl-anilines, diphenylamine, and α-naphthylamine has been studied. In the case of the first four compounds the sulphonic groups are completely replaced by halogens. No product is obtained from diphenylamine. The sulphonic groups in naphthylamine are not replaced by halogens though halogen derivatives are obtained in most cases.

96. Nitration of Anthracene and its Derivatives.

P. S. VARMA *and* A. SUBRAMANYAM, Benares.

By treating anthracene with nitric acid, anthracene is converted partly into anthraquinone and partly into nitro-anthraquinones. All attempts to nitrate the di-nitro-anthraquinone have proved unsuccessful. Mono-bromo-anthraquinone is converted into bromo-nitro-anthraquinone at lower temperatures but at higher temperatures only nitro-anthraquinone is obtained. It has been possible to get a bromo-di-nitro-anthraquinone also by increasing the quantity of nitric acid. In the case of chloro-anthraquinone only a mono-nitro-derivative has been obtained. Under the same conditions iodo-anthraquinones are decomposed into anthraquinone and iodine.

97. The Oxidation of the Paraffin Wax (Preliminary).

P. S. VARMA *and* H. R. KRISHNAN, Benares.

Attempts have been made to oxidise the paraffin wax by means of atmospheric oxygen in presence of nitric oxide at different temperatures. In the oxidation products at 140–145° (total yield 70%) arachidic, non-decoic, palmitic acids and a C_{12}-hydroxy acid have been obtained; at 170–175°C (yield 76%) in addition to the above tridecoic acid and hydroxy tridecoic acid have been obtained. Small quantities of carbon dioxide, acetic acid, butyric acid, and nitroethane have also been found among the oxidation products.

98. The Reduction of *o*-Nitrotoluene.

P. S. VARMA *and* V. ANNA RAO, Benares.

Magnesium powder in presence of methyl or ethyl alcohol and aqueous ammonium chloride solution gives *o*-azoxytoluene (89%). Zinc dust under similar conditions and stannous chloride (in alkaline medium) also yield *o*-azoxytoluene. *o*-Azotoluene is obtained by the action of sodium methoxide or ethoxide at 100°. Aluminium wire (or dust), zinc dust, and stannous chloride (alkaline medium) also yield *o*-azotoluene. With aluminium or zinc dust *o*-hydrazo-toluene is also obtained. A good yield of hydrazo-toluene is obtained by the action of ammonium sulphide on *o*-azotoluene. *o*-Toluidine is the main product when sodium sulphide or tin or stannous chloride in hydrochloric acid is used as a reducing agent.

99. NITRATION OF *m*-dichlorobenzene.

H. S. JOIS *and* B. L. MANJUNATH, Bangalore.

The products of the nitration of *m*-dichlorobenzene are 4 : 6-dichloro-1 : 3-dinitrobenzene (m.p. 102–103°, yield 80%), 2 : 4-dichloro-1 :3-dinitrobenzene (m.p. 70–73°, yield 5%), and 3 : 4-dichloro-1 : 2 dinitrobenzene (m.p. 50–53°, yield 5%). The formation of the latter would be the result of a re-arrangement of the molecule during the process of nitration.

100. 2 : 4-Dinitrophenylhydrazine as Re-agent for Sugars.

VINAYAK NARAYAN PATWARDHAN, Bangalore.

2 : 4-Dinitrophenylhydrazine forms the corresponding hydrazones with monosaccharides. Compounds with glucose, mannose and arabinose have been prepared.

101. Action of Light on Tyrosinase.

D. NARAYANAMURTI *and* C. V. RAMASWAMI AYYAR, Bangalore.

Tyrosinase (J. Ind. Inst. Sc., 1929, **12**A, 109) is activated by exposure to the rays from a quartz mercury lamp. The effect has been studied with regard to the purity of the preparation, pH, etc. The mechanism of activation by the rays has also been investigated both from the physico-chemical and chemical points of view.

102. Purification of Tyrosinase.

D. NARAYANAMURTI *and* C. V. RAMASWAMI AYYAR, Bangalore.

Tyrosinase (prepared from *Dolichos lab lab*) purified by the following methods has been studied: (*a*) ordinary dialysis, (*b*) electro-dialysis, (*c*) ultrafiltration, (*d*) electro-ultrafiltration, (*e*) repeated precipitation of the dialysed extracts with alcohol, and (*f*) adsorption followed by elution. The influence of netural salts on these preparations has also been investigated.

103. Proteins of Cumbu.

D. NARAYANAMURTI *and* C. V. RAMASWAMI AYYAR, Bangalore.

The major portion of the proteins occurring in cumbu (*Pennisetum typhoideum*) is best extracted by 70% alcohol. The protein thus extracted has been purified by repeated precipitation and the nitrogen distribution by Van Slyke's method and estimation of special units by colorimetric methods carried out. The physical properties of the protein have also been studied.

104. Proteins of *Dolichos Lab Lab*.

D. NARAYANAMURTI *and* C. V. RAMASWAMI AYYAR, Bangalore.

The kernel contains about 25% protein about 85% of which is extracted by water. To avoid tyrosinase action the extracts have been subjected to electrodialysis in a suitably constructed electrodialyser out of contact with air and the pure product so obtained has been investigated with regard to its nitrogen distribution and physical properties.

105. Influence of Charcoals on the Biological Oxidation of sulphur.

C. V. RAMASWAMI AYYAR, Bangalore.

Charcoals (ordinary as well as ash-free) have been found to exert a marked influence on the biological oxidation of sulphur. The results of experiments conducted to elucidate the mechanism of this activation are discussed.

106. The nature of amylase. Part II.

D. NARAYANAMURTI, Bangalore.

Amylase is considerably increased in activity on electro-ultrafiltration. Further evidence based on ultrafiltration experiments is brought forward in support of the two-enzyme theory of amylase.

107. Chemical study of the Germination of Groundnut.

D. V. KARMAKAR, Bangalore.

Groundnut (*Arachis Hypogea*) contains about 50% oil, 30% protein, 10% sugars and a little starch. On germination, the oil decreased from 46·8 to 25·96% and was accompanied by an increase in starch content from 3.6 to 17.0%. Sugar decreased in the beginning but later there was increase up to 13%. Cotyledons and embryos were also examined separately. Total protein remained unaltered throughout the period of the investigation.

108. Fermentation of Pentoses by *Bacillus Acetoethylicus.*

VINAYAK NARAYAN PATWARDHAN, Bangalore.

The hydrolysed product of straw served as the fermenting medium. Dry straw was extracted with sulphuric acid (6%) by steaming for six hours at atmospheric pressure. The extract was concentrated and the sugar content was brought to 7 or 8%. The bacillus which had been specially trained to ferment high concentrations of sugar was inoculated in the sterile medium. The fermentation was allowed to proceed for 8-10 days and the contents distilled. Sugar from the residue and alcohol and acetone from the distillate were estimated.

About 86% sugar disappears during fermentation. The alcohol and acetone together amount to about 23-25% of the sugar fermented. Favourable conditions leading to a higher yield of the alcohol and acetone mixture are being worked out.

109. Amylase from *Eleusine Coracana.*

VINAYAK NARAYAN PATWARDHAN *and* NUGGEHALLI NARAYANA, Bangalore.

The enzyme from the malt was extracted with 20% alcohol and precipitated by 95% alcohol. Examination of the hydrolysing action showed the enzyme to be actively liquifying and saccharifying. The action of the enzyme on potato starch has been studied. The optimum temperature for the enzyme lies between 55° and 60° and optimum reaction is between pH 4.8 and 5.0 The precipitated enzyme as well as the extract loses its activity after long dialysis in collodion bags at a temperature of 3°-4° C. In this behaviour it resembles the amylase from *Zea mais.*

110. Asparaginase from maize.

C. V. Paramasivan, Bangalore.

The enzyme was prepared from germinated maize which was ground with quartz sand in a mortar with nearly two to three times its weight of water and filtered through cloth. The liquid was centrifuged and the enzyme precipitated by the additon of a sufficient quantity of ice cold 90% alcohol; separated by centrifuging, washed with ether, dried at 30°, powdered and preserved. The action on asparagine was followed by estimating the amount of ammonia formed from time to time. The effects of reaction, dialysis, inorganic salts, and amino-acids on the course of the hydrolysis were studied. The velocity constant calculated according to the monomolecular formula was observed to increase with time.

111. Studies on some proteolytic enzymes of vegetable origin. Part I.—Peptidases.

C. V. Paramasivan, Bangalore.

The enzymes from malted cholam and maize were prepared and the conditions relating to their action on some of the simpler dipeptides were studied.

112. Studies in the nutrition of the lac insect. Part VI. —A physico-chemical study of the tissue fluids of some host plants.

B. H. Krishna *and* M. Sreenivasaya, Bangalore.

The hydrogen-ion-concentration, buffer value, osmotic pressure, and electrical conductivity of the tissue fluids have been determined at different periods of the insects' life-cycle. Tissue fluids having a reaction range of pH 5—5.5 are found to be more suitable than more alkaline fluids. Higher buffer values characterise the tissue fluids derived from stems attacked by insects.

The mean M.W. of the solutes in the fluids, calculated from the total solids and the osmotic pressure point to the presence of substances of high molecular weight in the tissue fluids of host plants which are reputed to be excellent hosts for lac production.

113. Studies in the nutrition of the lac insect. Part VII. —Biochemical changes induced in the host on insect attack.

B. H. Krishna *and* M. Sreenivasaya, Bangalore.

A sudden increase in the nitrogen and phosphorus contents without a proportionate increase of calcium in the tissue fluids of the stem is brought about through the attack of the insect. Generally, the drain effected by the insect on the host is with regard to nitrogen, phosphate, and carbohydrates. If the heavy demand of nitrogenous and phosphatic materials is met by direct application of suitable manures, the host will yield heavy crops of la and big swarms of larvæ.

With regard to the carbohydrate supply, however, a predominant accumulation of starch in the stems should be ensured before the infection.

114. Studies in the nutrition of the lac insect. Part VIII. —Nutrition in relation to parasitism.

B. H. Krishna *and* M. Sreenivasaya, Bangalore.

The high acidity (4·7 pH) of the body fluids of the insect is maintained to resist the growth of internal parasites and this is connected with the calcium metabolism of the insect. The predators which feed on the insect are defended against through the insects' secretary activity which is largely dependent upon the host. Leguminous hosts like *fleminga congesta, cajanus indicus,* and *butea frondosa* are poor hosts from the point of view of the resin secreting efficiency of the insect. Insects fed on these hosts are helpless against the attack of predators like *E. amabalis* etc., whereas those on *shorea tolura* build thick and tough encrustations, which effectively protect them from their predatory enemies. Well-fed insects maintained in a vigorous state of health can resist their enemies to a very large extent, through their defensive mechanisms of steady secretion of lac and incessant excretion of honey dew.

115. A note on the nitrogenous and fatty constituents of the blood of lac insects.

B. H. Krishna *and* M. Sreenivasaya, Bangalore.

A method for the isolation of fats and proteins from insects has been described.

The globulin has been analysed and the nitrogenous constituents of the serum have been partitioned.

A comparatively high basic fraction characterises the serum component of the proteins from the lac insect.

The economic value of this investigation is indicated.

116. The determination of pyruvic acid in biological fluids in the presence of lactic acid, acetaldehyde, and glucose.

B. H. Krishna, Bangalore.

The method of Krishna and Sreenivasaya (*Biochem. J.*, 1928, **22**, 1169) has been simplified. Differences observed in the rates of oxidation of pyruvic acid and lactic acid, acetaldehyde, and glucose by ceric sulphate in acid solution permit of an electrometric titration of pyruvic acid in the presence of these substances.

The inflection point in the titration curve $\frac{dE}{dv}$ against V, is taken as the end point.

The effects of dilution and hydrogen-ion concentration during titration both of which have a pronounced effect on the result, and the process of treatment preliminary to titration of biological fluids are discussed.

117. A microchemical study of the organic acids in healthy and spiked sandal leaves.

A. V. Varadaraja Iyengar, Bangalore.

Oxalic, malic, citric, succinic, and tartaric acids were noted to be normally present in sandal leaves. Their relation to health and disease was studied.

118. A micro-method for the estimation of calcium in plants.

P. V. VARADARAJA IYENGAR, Bangalore.

A rapid and convenient method is described by which it is possible to estimate the amount of calcium occurring even in individual leaves.

119. Haemolysis by narcotics. Part I.—The haemolysis of red blood corpuscles by some primary and secondary amines and allied substances with reference to the hydrogen ion concentration of the solutions used.

K. C. SEN, Muktesar.

The substances used are methylamine, ethylamine, diethylamine, piperidine, ammonia, and potassium hydroxide. When a comparison was made of the haemolytic powers of these substances with the hydroxyl ion concentration of the aqueous solution, a direct proportionality was observed. Thus with increase in the electrical conductivity of the solutions at the same dilution, the haemolytic efficiency also increased. Hence the pH of the solutions gave an indication of the lytic power of the substances. Since however the hydrogen ion concentration is the deciding factor in haemolysis in these cases, the important point of the permeability of these narcotics into tissues and cells has now to be considered in relation to their surface tension effects. A study of this appears to show that the lytic efficiency is more determined in these cases by the alkalinity or OH-ion concentration of the solutions than by their surface tension effects. A comparative study in this connection of the haemolytic efficiency of several fatty acids like formic, acetic, propionic, butyric, valeric, and caproic acids also show that the hydrogen ion concentration is more effective than the surface tension effects in making the cell membrane permeable to haemoglobin.

120. The composition of the globulin of the Indian gram, *Cicer arietinum* by nitrogen distribution.

T. R. GOEL, L. S. NIGAM, *and* H. N. BATHAM, Cawnpore.

(1) The globulin of the Indian gram has been isolated and analysed.

(2) The analytical results indicate that it contains the basic amino-acids, arginine, histidine, lysine, and cystine.

121. Polar adsorption in relation to Traube's surface tension rule.

SOCHINDRA NATH CHAKRAVERTY, Allahabad.

Traube's rule has been found to be in accord with many cases where the adsorption is not markedly polar. In order to find out whether a strongly polar adsorption would give the same series of adsorption isotherms as a non-polar one, the solutes and the medium remaining the same, a large number of experiments have been carried out with zirconium hydroxide as the adsorbent and some fatty acids as well as some amino-acids as the adsorbable solutes. It has been observed that stronger the acid is, the greater is its adsorption, and the chemical affinity existing between the surface of the adsorbent and the solute more than counterbalances any capillary effect. The adsorption series with formic, acetic, propionic, and butyric acids is just the reverse of what we get in the Traube series. Almost similar results are obtained with amino-acetic, amino-propionic, and amino-benzoic acids, where the acidic dissociation constant of the acids gives a comparative order of adsorbability when the same series of analogous solutes are considered. It is apparent therefore that in these cases Traube's rule is not obeyed due to the strongly polar nature of the adsorption.

122. Sensitisation of red blood corpuscles by bile salts, brilliant green, and other substances and hemolysis by hydroxyl ions.

A. C. ROY, Allahabad.

In order to find out a possible explanation of the action of normal serum on the sensitised corpuscles, the present author has carried out a number of experiments with bile salts, soaps, dyes, etc., with the subsequent addition of low concentration of sodium hydroxide. It has been observed that by suitably sensitising the corpuscles, an almost permanent change occurs in the membranes of the red blood corpuscles which manifests itself by a greatly increased susceptibility to the presence of hydroxyl ions, and a rapid hemolysis occurs. From experiments on brilliant green it has been observed that the dye is adsorbed by the corpuscle membrane and it appears possible that the sensitising action of bile salts, soaps, etc., is due to the adsorption of these substances by the membrane of the red blood corpuscles. It appears also possible that the action of normal serum on the hemolysis of the sensitised corpuscles may be due to the alkali content of the serum.

123. The effect of some primary and secondary amines on red blood corpuscles sensitised by bile salts.

NARENDRA NATH MITTRA, Allahabad.

The hemolysis of red blood corpuscles can be carried out separately by bile salts as well as by different amines when the concentrations of these re-agents reach a certain limit. When however, less amounts of these lytic agents are used, no hemolysis occurs. In certain cases, however, a sort of sensitisation of the corpuscles can be observed when a low amount of any of these lytic agents is kept in contact with the corpuscles for some time and these sensitised corpuscles are then extremely susceptible to a slight addition of hydroxyl ions in any form. Rai in another communication has considered the case of sensitisation towards sodium hydroxide under certain conditions, and in this communication the author desires to present a large number of results of the effect, of several amines such as ethyl amine, diethyl amine, methyl-amine, etc., on the sensitised corpuscles. The concentration of the amines was varied to a great extent, in some cases a solution of strength M/10,000 being used, and the result shows that a very low concentration of the amines is quite an efficient hemolyser of the sensitised corpuscles whereas for the unsensitised corpuscles, an appreciably higher amount of the amines would be necessary for the hemolysis to take place. The general theory underlying the whole process of sensitisation has also been discussed.

124. Nitrogen fixation by Azotobacter Chroococcum in soils in the presence of certain salts.

N. N. INUGANTI *and* K. HABIB HASAN, Hyderabad, Deccan.

Work was continued (Proc. Ind. Sc. Congress, Madras) to find out how far the nitrogen fixation is affected in soils containing salts of sodium, potassium, and magnesium. In all these experiments pure cultures of azotobacter were inoculated and incubated at 37°C for a period of six weeks.

Few interesting observations were made as under :—

(1) Sodium chloride does not affect the activity of the azotobacter even up to 2.5%, the highest amount of fixed nitrogen being when at 0.08% beyond which slight diminution takes place.

(2) Sodium sulphate is only favourable when present in minimum quantity, *viz.*, 0.01%. When increased there is a gradual diminution in the nitrogen inasmuch as at 2.5% it is almost halved.

(3) Potassium sulphate gives the highest quantity of fixed nitrogen when at 0.1% beyond which there is a slight diminution but even at 2.5% nitrogen is more than what is fixed when the salt is at .01% or .05%

(4) Potassium carbonate seems very favourable even at 2.5%. From the start, *viz.*, .01% to this degree the increase in nitrogen is very little and nothing appreciable. This varied proportion of the salt neither increases nor diminishes the activity of the organism.

(5) Higher percentages of magnesium sulphate and magnesium carbonate diminish the activity of azotobacter, the most favourable being at .01% and .05% respectively.

(6) None of these salts is found to destroy the activity of the organism even in higher percentages whereas in some cases it is increased and in others it is diminished.

(7) In all trials it was found necessary to neutralise the acidity in order to maintain the degree of activity of the organisms.

125. Chemical analysis of Standard Indian Cottons.

D. L. Sen, Bombay.

Quantitative determination of the various chemical constituents of eighteen standard Indian cottons of the three successive seasons, (1926–27, 1927–28, 1928–29) has been carried out.

The differences exhibited, between the three seasons, in each of the various constituents is discussed for each cotton, and also the differences, between the eighteen cottons, in each of the constituents for any one of the three seasons.

The practical significance of these chemical constituents in the process of dyeing, bleaching, and spinning is also briefly discussed.

126. Influence of different reducing agents on one-bath chrome-liquor.

B. B. Dhavale *and* G. N. Pal, Calcutta.

It was proved that :—

(1) Even though a start was made with the same quantities of potassium bichromate and sulphuric acid, different reducing agents produced chrome-liquors of basicities varying widely from each other.

(2) Irrespective of the different basicities produced by these different reducing agents, the contention that the absorption of chromium by the pelt increases with the increase in the basicity figure of the chrome-liquor is borne out.

(3) From the examination of the leathers produced by these chrome-liquors, it is found that the organic reducing agents make the fibres more felty and the penetration of the dye deeper than the inorganic ones.

127. The Effect of addition of sodium chloride to chrome-liquor.

B. B. Dhavale *and* G. N. Pal, Calcutta.

The effect of adding different amounts of salt to the chrome-liquor during chrome tanning was studied. Results obtained show that the addition of 5% salt on the pelt-weight leads to the highest absorption of chromium by the leather and as the use of this proportion happens to be the tanner's practice. The present investigation justifies by scientific experiments the empirical finding of the practical tanner. The comparative study of the qualities of the finished leathers obtained in the course of the investigation leads to the conclusion that it is advantageous to add about 5% salt to the chrome-liquor during tanning.

128. Effect of sodium chloride on lime-liquor.

B. M. Das *and* U. N. Dutt, Calcutta.

Investigations were carried out to study the effect of adding salt to the lime-liquors in the manufacture of leather. Results obtained show that salt increases the swelling of the hides in lime-liquor and also helps in the production of a leather having tighter and finer grain.

129. On the use of zinc chloride in tanning.

B. M. Das *and* U. N. Dutt, Calcutta.

Investigations were made to find out the effects of zinc chloride in the soaking and pickling processes in connection with the manufacture of chrome box sides. The results show that a finer and tighter grained leather is obtained by the zinc chloride treatment.

130. On the resistance of shellac films from various varnishes to the action of water and chemicals.

M. Venugopalan *and* M. Rangaswami, Ranchi.

In continuation of a study of the advantages of employing mixed solvents for shellac varnish, an examination of the films from solutions in some mixed solvents has been instituted.

The effect of water, brine, acid, alkali, and a few gases on the appearance and structure of films from different varnishes has been discussed. Different films possess different capacities for water absorption but the effect on the appearance and structure of the films are in all cases only temporary. Brine, acids, and the gases experimented with have no effect on the films and immersion in dilute alcohol, very little. A strong alkali, however, has been found to destroy the film in all cases to a smaller or greater extent.

In the various tests, mixed solvents have generally been found to give better films than single .solvents and mixtures of methyl alcohol or ethyl alcohol with acetone have been observed to offer the greatest resistance to the action of water and chemicals tested.

131. A preliminary survey of the problem of fuel economy in the United Provinces.

N. G. Chatterji, Cawnpur.

The investigation has the following objects :—

1. General economy in coal consumption in factories to reduce the fuel bill.

2. Prevention of atmospheric pollution by smoke from factory chimneys.
3. To replace wood by coke as domestic fuel, for the conservation of forests or for their utilisation for more useful purpose.
4. To find a suitable substitute with proper distribution organisation of the cowdung cake fuel.

132. Mond gasification of water-hyacinth.

H. K. SEN *and* H. N. CHATTERJEE, Calcutta.

In view of the possible commercial utilisation of the weed by gasification, experiments have been undertaken to critically examine its suitability in this direction. Gasifying at 600° in the presence of air saturated with water vapour at 65°, the maximum quantity of ammonium sulphate per ton of air dry hyacinth has so far been 82 lbs. only. The economic aspect is also discussed.

133. The Utilisation of Wood Tar.

Y. K. RAGHUNATHA RAO, Bangalore.

Attempts have been made to utilise the wood tar from the Mysore Iron Works in different ways. It has been found that on a small scale, lamp-black of good quality can be produced but the burning of the tar on a larger scale offers considerable difficulty. It appears better to utilise only certain fractions for this purpose.

The pitch can be utilised to some extent as a paint and the phenolic bodies yield interesting formaldehyde condensation products.

In conjunction with Mr. B. Sanjiva Rao an examination of the constituents of the tar has been undertaken and numerous complex substances found to be present in it.

134. Studies in the Michael's Reaction.

UMA PRASANNA BASU, Calcutta.

An investigation into the mechanism of the condensation between cyanoacetamide and β-diketones is being made and certain results have already been obtained which indicate that in all such reactions it is the ethylenic linkage formed by the isomeric change of the β-diketones into their enolic modifications which is responsible for the initial condensation, and consequently this view supports the general principle that in a conjugated system of the type $-\overset{|}{C}=CH-\overset{|}{C}=O$, the ethylenic linkage is more reactive than the carbonyl.

Ethyl 3-cyano-6-methyl-2-pyridone-4-carboxylate was obtained by condensing sodio-cyanoacetamide and acetone-oxalester both in alcoholic solution and in ethereal suspension. That the reaction takes place through the enolic phase is evident from the fact that *o*-ethyl-acetone-oxalester, Et. COO. C(OEt)=CH. CO. Me, also gave rise to the same product. Similarly 3-cyano-4-phenyl-6-methyl-2-pyridone was obtained by condensing *o*-methyl-benzoylacetone, Ph. C(OMe)=CH. CO. Me, with sodio-cyanoacetamide. Certain other interesting observations have been made from an attempt to ascertain the position of the sodium atom in the condensation product between acetyl-acetone and sodio-cyanoacetamide. It is now found that the Michael product is the N-Na salt of 3-cyano-4 : 6 dimethyl-2-pyridone. Consequently by condensing acetyl-acetone with sodio-cyanoacet-methyl-amide, the condensation product N-methyl-3-cyano-4 : 6-dimethyl-2-pyridone was directly obtained as was also derived from the methylation of the sodium salt of the former compound. A probable mechanism of the reaction has been suggested, which again indirectly supports the much criticised Thiele's theory. Further work is in progress.

135. Synthesis in the Thiazole Series.

INDU BHUSAN SEN-GUPTA, Calcutta.

The interaction of aniline and other aromatic amines with monochloroacetyl chloride leads at first to the corresponding amide, which, on being treated with potassium sulphocyanide in alcoholic solution gives two products of the composition—

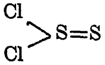
$$\mathrm{RNH\,.\,CO\,.\,CH_2\,.\,CNS.}$$

These may be regarded as having been derived from two forms of potassium sulphocyanide. Experiments to convert them into closed ring compounds are in progress.

136. Studies in organic polysulphides. Part I.

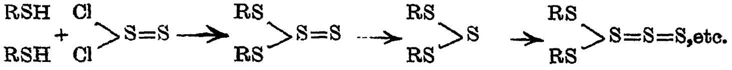
INDU BHUSAN SEN-GUPTA, Calcutta.

Interaction of mercaptans and S_2Cl_2, generally gives rise to a mixture of R_2S_2, R_2S_3, R_2S_4 and R_2S_6, in which R_2S_3 predominates. The alkyl and aryl derivatives of this type have been prepared, the former being high boiling liquids, and the latter crystalline solids having sharp melting points. R_2S_3 may also be derived by the action of R.S.Cl and Na_2S in ethereal or chloroform suspension in a practically pure condition. R_2S_4, and R_2S_5, have similarly been prepared from Na_2S_2, and Na_2S_3, respectively. This implies the probable existence of S_2Cl_2, mainly in the form



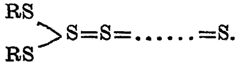
$$\begin{matrix}\mathrm{Cl}\\ \mathrm{Cl}\end{matrix}\!>\mathrm{S{=}S}$$

and the different polysulphides are therefore derived from the addition of different quantities of sulphur to the end sulphur atom:—



$$\begin{matrix}\mathrm{RSH}\\ \mathrm{RSH}\end{matrix}+\begin{matrix}\mathrm{Cl}\\ \mathrm{Cl}\end{matrix}\!>\mathrm{S{=}S}\longrightarrow\begin{matrix}\mathrm{RS}\\ \mathrm{RS}\end{matrix}\!>\mathrm{S{=}S}\longrightarrow\begin{matrix}\mathrm{RS}\\ \mathrm{RS}\end{matrix}\!>\mathrm{S}\longrightarrow\begin{matrix}\mathrm{RS}\\ \mathrm{RS}\end{matrix}\!>\mathrm{S{=}S{=}S,etc.}$$

The alternate constitution Cl-S-S-Cl, for sulphur monochloride would require the union of the various alkyl or the aryl radicals through a chain of sulphur atoms from which the various polysulphides are derivable by rupture of the chain and subsequent re-union; preference therefore is given to the former constitution for sulphur monochloride, and consequently that of the polysulphides becomes

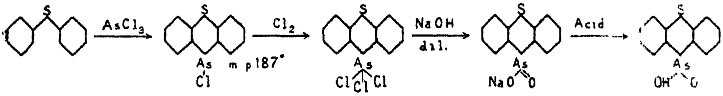


$$\begin{matrix}\mathrm{RS}\\ \mathrm{RS}\end{matrix}\!>\mathrm{S{=}S{=}\ldots\ldots{=}S.}$$

137. Thioarsines.

INDU BHUSAN SEN-GUPTA, Calcutta.

The great therapeutic value of sulphur and arsenic led to an attempt to synthesise derivatives containing both these elements in suitable positions with respect to each other. Whilst the pharmacological investigations await, the following reactions have been realised; by heating equimolecular quantities of the sulphides and arsenic trichloride to about 200° in an oil-bath, for about an hour a brown solid mass is left behind which on crystallisation from carbon tetrachloride and acetylene tetrachloride is obtained in well-defined crystals with definite melting points:—



Similar derivatives have also been obtained from naphthyl and nitrophenylsulphides, etc.

138. Reduction of aromatic nitro-compounds with sugar.

TARINI CHARAN CHAUDHURI, Pabna.

Among other reduction products isomeric azo-benzenes have been obtained.

139. A new formula for fluoremetry.

K. S. G. DOSS, Bangalore.

For the micro-analysis of fluorescent substances L. J. Desha (J.A.C.S., **42**, 1363) has suggested the use of Kober's nephelometric formula. This formula is purely empirical. The present paper deals with a new formula which agrees well with experimental results. In this formula the fluorescent intensity is calculated from the incident intensity by putting Perrin's idea of protective action into a quantitative form. Correction for absorption is made on the basis of Lambert and Beer's law. The final intensity is thus expressed as a function of the depth of the solution and the concentration of fluorescent substance. The formula is specially applicable to cases in which the duration of the critical state is small (*e.g.*, alkaline solution of fluorescein).

140. The Photo-chemical and dark reaction between bromine and organic hydroxy-acids in presence of potassium bromide.

J. C. GHOSH *and* R. M. PURKAYASTHA, Dacca.

It has been observed that—

(1) the dark reaction between pure bromine and organic acids like phenyl-lactic acid, mandelic acid, and lactic acid (*a*) is bi-molecular even when the organic acid is in large excess, (*b*) becomes monomolecular in presence of potassium bromide.

(2) the photo-chemical reaction between pure bromine and the above acids (*a*) is monomolecular when the acids are in large excess, (*b*) becomes zero-molecular in presence of potassium bromide.

An attempt has been made to explain this remarkable diminution in the order of reaction under the influence of (*a*) light, and (*b*) potassium bromide.

141. Raman Effect in Fused Naphthalene.

N. G. MITRA *and* D. L. SHRIVASTAVA, Lahore.

Raman spectra has been taken using naphthalene in the fused state. The frequency changes found, follow in general those obtained by other workers with naphthalene in organic solvents.

142. Relation between the intensity and the velocity of the reaction between sodium nitrite and iodine in visible and infra-red radiations.

A. K. BHATTACHARYA *and* N. R. DHAR, Allahabad.

It has been observed that the relation between the velocity of a reaction and the intensity of the incident radiation can vary from any proper fraction to 2 depending on the ratio of the thermal and photochemical velocities of the same reaction. In the case of the reaction between sodium nitrite and iodine the relation between velocity and intensity varies from 1/3 to 3/2. In order to accelerate the dark reaction a very small amount of potassium iodide was used in dissolving the iodine. Both sodium acetate and borax were used as buffer solutions.

The absorption of the incident radiation has been determined by a radio-micrometer. The amount of radiation absorbed is directly proportional to the intensity of the incident radiation.

143. Chemical reactions in infra-red radiations.

A. K. BHATTACHARYA, Allahabad.

The kinetics, temperature co-efficients, and quantum efficiency of several chemical reactions have been investigated under the influence of radiations of mean wave-lengths 7,304 Å, using Wallace M and S filters and in light using solution filters (saturated dichromate solution kept in a cobalt glass cell 1 cm. thick).

The changes in the reactions studied were determined either by suitable titrations or spectrophotometric measurements.

The temperature co-efficients of all these reactions (wave-lengths 7,304 Å and 8,000 Å) are less than those of the corresponding dark reactions. The quantum efficiency of all these reactions usually increases with increasing temperature.

Measurements of extinction co-efficients show that all radiations of wave-length from 4,400 Å to 7,000 Å are absorbed by the reacting systems and thus they are accelerated by the absorption of the incident radiation.

144 Experiments in photosynthesis.

G. GOPAL RAO *and* N. R. DHAR, Allahabad.

While repeating some of the experiments of (J. Phys. Chem., **29**, 926, 1925) on the photosynthesis of formaldehyde we found that a solution of methylene blue, through which a current of dry carbon dioxide was passed, while exposed to sunlight, became slightly less intense in colour than a similar solution exposed to the sun but through which no carbon dioxide was passed. It was suspected that some of the methylene blue might have been oxidised by carbon dioxide in presence of light. Suspensions of chlorophyll in water showed a behaviour exactly similar to that of methylene blue solutions. It was recalled that Chakravarthi and Dhar (Z. anorg. Chem. 1925) had shown that certain dyes can act as reducing agents under suitable conditions. On the subsequent experiments a current of dry carbon dioxide was passed through a solution of methylene blue or a suspension of chlorophyll exposed to light from a 500 watt gas-filled tungsten filament lamp and the issuing gas tested for carbon monoxide by the iodine pentoxide method. Small quantities of carbon monoxide were always detected. Comparison with blank experiments showed that the amount of carbon monoxide found is considerably higher in the presence of chlorophyll and methylene blue than in their absence. We, therefore, conclude that, besides its photo-sensitising action, chlorophyll also exerts a slight reducing action. These facts are calculated to throw considerable light on the carbon assimilation by plants.

145. Photo-chemical oxidation of salts of some organic acids, lecithin, cholesterol, and some food materials by air.

C. C. PALIT, Allahabad.

1. Aqueous solutions or suspensions of the following substances have been oxidised by passing air in presence of sunlight:—sodium formate, sodium tartrate, lecithin, cholesterol, butter, milk, egg-white and egg-yellow.
2. Zinc oxide acts as a photo-sensitiser in the oxidation of sodium tartrate and formate.
3. Photo-chemical oxidation of glucose, starch, glycogen, glycine, α-alanine, hippuric acid, urea, sodium urate, formate, tartrate, potassium stearate, and oleate is markedly increased in presence of ferric nitrate and uranium nitrate.
4. Dilute solutions of lactic acid, oxalic acid, tartaric acid and citric acid are appreciably oxidised by air in presence of sunlight and the order in which they are oxidised is:—oxalic > lactic > tartaric > citric.
5. Experimental results on the estimation of carbon dioxide prove that glucose, glycine, potassium oleate, lecithin, cholesterol, butter, etc., are oxidised by air in presence of sunlight chiefly to carbon dioxide and not to any intermediate product.
6. Our experimental results show that the amount of oxidation increases with (*i*) the amount of light falling on the solutions, and (*ii*) the time of exposure.
7. Comparative experiments show that the order in which the food materials are oxidised in presence of sunlight is as follows:—egg-yellow > starch > egg-white, butter > glucose.
8. Einstein's Law of Photo-chemical Equivalence is approximately applicable to the photo-chemical oxidations of glucose, lactose, and alanine by air.
9. Experimental results show that appreciable amounts of the compounds of the peroxide type are formed when air is passed through aqueous suspensions of cholesterol, olive oil, and butter. Moreover appreciable amounts of glucose have been oxidised by mixing the solution of glucose with exposed cholesterol, olive oil, and butter containing the peroxide compounds. Hence it is believed that the antirachitic and beneficial properties of substances not containing the necessary vitamins are due to the presence of peroxides which help the oxidation of food materials in the animal body.

146. Photolysis of potassium-cupri-oxalate.

W. V. BHAGWAT *and* H. L. DUBE, Allahabad.

It has been observed in this laboratory that a solution of potassium-cupri-oxalate is decomposed in light and the velocity of this photochemical reaction is greatly accelerated by ferric and uranyl salts.

We have carried on quantitative experiments on this reaction. In presence of ferric chloride, the velocity of the photochemical decomposition of potassium-cupri-oxalate appears to be zero-molecular in sunlight and is independent of the concentration of the photolyte. An excess of potassium oxalate has little influence on the reaction. Similar results have been obtained by Allmand and Webb (J. Chem. Soc., 1518, 1929) in the photolysis of potassium-ferri-oxalate.

147. Photodecomposition of nitrous acid.

K. S. MURTI, Allahabad.

Solutions of nitrous acid decompose in darkness at the ordinary temperature. In presence of light the decomposition is greatly accelerated. In bright sunlight, the velocity of decomposition in open vessels is approximately three times that in the darkness and that in the total light from a 1,000 watt tungsten filament lamp is a little more than two times the velocity of decomposition in the dark.

It appears that the temperature co-efficient of the photochemical decomposition is greater than unity.

The velocity of decomposition increases with the increase of the initial concentration of nitrous acid.

In all these reactions, the velocity constant follows the unimolecular formula.

Experiments on the quantum yield with the different wave-lengths and at different temperatures, and on the variation of velocity with the pressure of nitric oxide in the reaction vessel are in progress.

148. Chemi-luminescence in the oxidation of fluorescent and non-fluorescent substances by hydrogen peroxide and ozone.

N. N. BISWAS, Allahabad.

1. When numerous fluorescent and non-fluorescent dye solutions are oxidised by hydrogen peroxide and ferrous sulphate, a glow, which is visible in a dark room, is observed
2. The wave-lengths of the radiations given out in the glow obtained in the oxidation of some fluorescent dyes, by ozonised oxygen have been measured.
3. Silica containing small quantities of neutralised dyes in the adsorbed state when suspended in ethyl alcohol and ozonised oxygen is passed through the suspension a glow is observed.
4. When small amounts of a dye, which *gives out good glow,* are mixed with another dye of which the glow is feeble, the resulting glow obtained by passing ozone, is more intense than that obtained with the dye yielding feeble glow
5. Increase of temperature of the reacting substances leads to the intensification of the glow in the oxidations of reducing agents by ozone or hydrogen peroxide.
6. Increase of concentration of the reducing agents causes an increase of the intensity of the glow up to a limiting value; if the concentration is increased further, the glow becomes feeble and finally stops.

149. Photochemical activity of tungstic and molybdic acid sols.

A. K. BHATTACHARYA *and* S. GHOSH, Allahabad.

Several years ago, Wessiljewa (Z. wiss. phot., 1913, **12,** 1) found that tungstic acid sol when freshly prepared can be reduced to blue coloured lower oxide by reducing agents like glucose, formaldehyde, alcohol, etc., and that this reduction is photosensitive. On ageing tungstic acid loses its photosensitivity remarkably, and it can be regained by heating the sol. We have ascribed this behaviour of tungstic acid to the polymerisation of this substance on ageing, and evidence to this fact has been obtained by conductivity and viscosity measurements. We have now determined the effect of monovalent cations on the photochemical activity of tungstic acid sol and it is found that cations decrease the photosensitivity and are in the following decreasing order :—

$Rb^{\cdot} > NH_4^{\cdot} > K^{\cdot} > Na^{\cdot} > Si^{\cdot}$. The concentrations of the added cations are less than their precipitating concentrations. It is interesting to note that the coagulating powers of different monovalent cations are in the same order as the effect of the cations on the photosensitivity of the tungstic acid sol.

We have found that molybdic acid sol obtained by the interaction of ammonium molybdate and hydrochloric acid is also photochemically active when reduced by alcohol, grape-sugar, etc, and this property slightly diminishes when the sol is allowed to age, which can be regained by heating the sol. The monovalent cations decrease the photochemical activity in the following decreasing order:—$Rb^{\cdot} > NH_4^{\cdot} > K^{\cdot} > Na^{\cdot} > Li^{\cdot}$.

In one of our publications we have shown that the coagulating powers of different cations are also in the above order. Moreover, we have shown that molybdic acid sol contains appreciable amount of the substance in the molecular condition, which gradually polymerises on ageing.

The rate of reduction of tungstic and molybdic acids by reducing agents has been measured spectrophotometrically.

150. A new photo-tropic compound.

G. Sambamurti *and* N. L. Narasimham, Rajahmundry.

A photo-tropic compound of the composition I.Hg.S.S.S.Hg.I has been obtained with a bright yellow colour, which rapidly changes through green to grey on exposure to light, the colour, returning in the dark pretty quickly. The products of decomposition when brought into intimate contact have not produced the compound.

151. Studies in Triboluminiscence.

S. S. Bhatnagar, K. G. Mathur, *and* K. L. Budhiraja, Lahore.

Triboluminiscence of arsenious trioxide and saccharine have been studied in some detail. A method for the quantitative measurement of the intensity of triboluminiscence has been described. Fresh crystals of As_2O_3 have been found to rapidly lose their triboluminiscent properties when exposed to a strong beam of ultra-violet and X-rays. The temperature and the viscosity of the crystallising solution have also been found to have considerable influence on the triboluminiscent properties of the crystals and an explanation based on the possible separation of the supersaturated phase has been suggested.

152. Slow and induced oxidation of glycogen, lecithin, cholesterol, formate, oleate, stearate, and some food materials.

C. C. Palit, Allahabad.

1. An aqueous solution of sodium formate and an aqueous suspension of glycogen has been oxidised by air at 25° in presence of caustic soda, sodium bicarbonate, and different metallic hydroxides.

2. The oxidation of glycogen is retarded by fats and nitrogenous substances.

3. The induced oxidation of potassium stearate and oleate by air is retarded by carbohydrates and to a greater extent by a mixture of carbohydrate and urea.

4. The oxidation of carbohydrates by hydrogen peroxide and ferric sulphate is retarded by glycine potassium stearate and oleate.

5. Experimental results on the estimation of carbon dioxide prove that glucose, glycine, potassium oleate, lecithin, cholesterol. milk, egg-yellow, and egg-white are oxidised by air at 25° in presence of inductors chiefly to carbon dioxide and not to any intermediate product.

6. Comparative experiments have been carried on the induced oxidation of fats, carbohydrates, and nitrogenous substances to prove

whether nitrogenous matter is more readily oxidised than carbohydrates. The results show that in neutral solutions with cerous hydroxide as an inductor, the order in which the oxidation takes place is as follows:—Egg-white > egg-yellow > starch > glucose > butter. This order is the same as stated by Voit, the eminent physiologist, from physiological experiments.

7. These results on slow and induced oxidation of fats, nitrogenous substances and carbohydrates occurring either singly or in mixtures by air at the ordinary temperature are important, because these oxidations are of the same type as those taking place in the animal body.

153. Induced oxidation of carbohydrates and fats by passing air in presence of phosphorus.

S. N. Chakravarti, Allahabad.

1. Finely divided phosphorus has the greatest capacity of oxidising carbohydrates and fats, colloidal phoshorus comes next and small bits of phosphorus comes last.

2. In all cases excepting that of colloidal phosphorus the oxidation increases with time. In the case of colloidal phosphorus the amount of oxidation does not vary much with time.

3. It appears from my results that amongst the carbohydrates starch is oxidised to the greatest extent.

154. Period of induction in chemical reactions, Part III. Interaction of alkali iodates and hypophosphorous acid.

P. Neogi *and* Benoyendra Nath Sen, Calcutta.

A distinct period of induction has been observed in the interaction of hypophosphorous acid and iodates which takes place in successive stages. The phenomenon has been studied with reference to light, temperature, dilution, action of acids, salts, alcohols, and other substances. The velocity of the reaction has been measured and the successive stages ascertained from conductivity measurements. An interesting phenomenon is observed in the difference of the effects of isomeric alcohols like *n*-propyl and *iso*-propyl alcohols on the period of induction which might advantageously be utlised in differentiating the two isomeric alcohols.

155. The system-lithium hydroxide and oxyacids of phosphorus.

P. Neogi *and* Benoyendra Nath Sen, Calcutta.

The progressive neutralisation of the oxyacids of phosphorus with lithium hydroxide has been studied electrometrically and the different phases studied with reference to the various compounds formed.

156. Chemical reactions under electrodeless discharge.

S. S. Bhatnagar, R. K. Sharma, *and* N. G. Mitra
Lahore.

Various photo-chemical and other reactions have been tried under the electrodeless discharge with a view to study their mechanism. It has been found that some photo-chemical reactions follow the same trend as they do in light while the change observed in other reactions is quite different.

157. Chemical reactions under electrodeless discharge.

N. A. Yajnik, R. K. Sharma, *and* M. C. Bhatnagar,
Lahore.

The action of electrodeless discharge on a number of substances has been tried and it has been found that most of them are decomposed in a peculiar way. The phosphates and carbonates were found to be very stable towards the discharge and were not found to undergo any decomposition even on prolonged exposure.

It was also observed that in case of certian polymorphic substances, one modification was found to change into another under the influence of the electrodeless discharge.

158. Velocity of ionic reactions. Part IV.

A. N. Kappanna, Nagpur.

The paper deals with the kinetics of the reaction between sodium formate and potassium permanganate in neutral solutions. With only the reacting salts in neutral solutions, velocity measurements show that the reaction does not proceed in a simple manner. This has been found to be due to the variation in total ionic strength with the progress of the reaction. Velocity measurements have been made in the region 0·001 ω –0·05ω total ionic strength to examine the range of validity of Debye-Huckel limitation equation.

159. On the neutral salt effect: The activity co-efficient of hydrogen ions in mixtures of phosphoric acid and electrolytes.

Subodh Kumar Majumdar, Calcutta.

The effect of different concentrations of potassium chloride, potassium bromide, potassium iodide, and potassium sulphate on the activity coefficient of hydrogen ions in phosphoric acid solutions has been studied. Sulphates diminish hydrogen ion concentrations very markedly, while the halides show slight reverse effect. These effects have been discussed from different view points. The effect of dilution as also the addition of neutral salts have been studied in the light of the Debye and Hückel Equation and certain conclusions regarding the ionisation of phosphoric acid arrived at.

160. A contribution to the study of heterogeneous reactions.

D. D. Karvé.

The reaction between carbon disulphide and aqueous solutions of sodium hydroxide is a well-known heterogeneous reaction, in which the chief product of decomposition is sodium trithionate Na_2CS_3. It has been found that if hydrogen peroxide is present along with the alkali, the trithionate is oxidised rapidly and various products including sulphite, sulphate, carbonate, and free sulphur are produced. By using standard conditions (*e.g.*, constant rate of shaking, constant rate of passing drops of carbon disulphide through the alkali, etc.) and varying the concentrations of alkali as well as peroxide, the rate of the reaction (*i.e.*, the using up of the alkali) has been determined and conclusions drawn as regards the mechanism of the reaction.

161. The solubility of formaldehyde in organic solvents.

D. D. KARVÉ.

In connection with certain condensation reactions that are being carried out, it was necessary to use a solution of formaldehyde in various organic solvents. Solubilities in nitrobenzene, aliphatic, and aromatic hydrocarbons as well as carbon disulphide were determined by passing a stream of formaldehyde gas into the solvent until saturation was reached and estimating the aldehyde by oxidation to formic acid and titration with standard alkali. Partition co-efficients of formaldehyde between water and organic solvents have also been determined.

162. Sodium aluminate solutions. Part I.

S. M. MEHTA *and* N. G. JOSHI.

Electrical conductivities of solutions containing Na_20 and Al_20_3 in different ratios have been measured at 30°C and for concentrations ranging from 0.2N to 2N. The equivalent conductivity-normality curves show that for a given ratio of $Na_20 : Al_20_3$, the conductivity increases with dilution, as expected, due to the increased hydrolysis.

The curves obtained by plotting the equivalent conductivity against the ratio of $Na_20 : Al_20_3$ give a sharp maximum at the point corresponding to the ratio $2Na_20 : Al_20_3$. It appears that a salt corresponding to this ratio exists in solution and that the other ratios are, probably, mixtures of this with NaOH.

Further work on the determination of pH of these solutions is in progress.

163. A method for distinguishing isomeric, tautomeric, and polymeric from polymorphic optically active substances.

BAWA KARTAR SINGH, Cuttack.

A chemical substance may exist in two (or more) mutually convertible modifications. The difference between them may be due to isomerism (including tautomerism) or polymorphism. The solutions of isomeric substances will be different (unless tautomeric equilibrium has been established), whereas polymorphous substances will give identical solutions.

In this paper a new method for the diagnosis of polymorphous and isomeric modifications of optically active substances based on the above mentioned distinction is described. The rotatory power of the polymorphous modifications will be identical, whereas it will be different for isomeric or tautomeric forms. It is, however, possible for the rotatory dispersion curves of two different substances to intersect at a point corresponding to some wave-length and thus indicate identical rotatory power for that wave-length. The result will be that the modifications which are isomeric will appear as polymorphous. It is, therefore, suggested that the rotatory dispersions over a wide range should be measured. The value of the rotatory dispersion of the polymorphous modifications will be constant, whereas this will vary for isomeric substances. o-iodophenyl-imino-d-camphor occurs in three forms melting at 86–87°, 93°, and 96–97° respectively. The value of the rotatory dispersion for the three forms is identical, which shows that they are polymorphous and not stereoisomeric.

164. Studies in optical rotation.

S. M. Patel *and* P. C. Guha, Bangalore.

Organic compounds showing high molecular rotation have been prepared by Forster (J.C.S., 1909, *95*, 942; 1919, *115*, 889; 1921, *119*, 789) and Singh (J.C.S., 1919. *115*, 980, 1599; J. Ind. Chem. Soc., 1926, *3*, 389) by condensing camphorquinone with aromatic diamines. Camphorquinone has now been condensed with *p-p*-diaminodiphenylurea, and -oxamide, as also with thiocarbohydrazide; and all of the resulting compounds excepting the last have been found to possess high molecular rotations (*viz.,*) +8911°, +9141°, and +1556° respectively, in chloroform.

Further work involving the use of diaminodinaphthyl urea, –thiourea, and -oxamide, instead of the corresponding phenyl compounds, as also the study of rotations of the compounds obtained from aminocamphor and aromatic diketones and dialdehydes, is in progress.

165. The electrical conductivity in a gas subjected to ionisation by collision.

Shridhar Sarvottam Joshi, Benares.

On an analysis of the current voltage relationships in a discharge tube filled with a simple gas subjected to ionisation by collision due to fields such that their radiational effects in the space can be neglected, the following approximate equation has been theoretically deduced,

$$N={}^{aU\text{-}}/Z.$$

where, N is the number of ionic pairs per c.c., a denotes the number of fresh ions produced by collisions with an elctron during one centimeter of its path, U-is the electronic velocity in the direction of the applied field, and Z, the co efficient of ionic re-combination.

166. On the adsorption of gases by solids.

Ashutosh Ganguli, Calcutta.

The well-known adsorption formula of Langmuir,

$$c=\frac{k\eta}{1-\eta\beta}$$

(where c is the concentration, η, the amount adsorbed, being reciprocal to surface area Ω covered by the adsorbed substance, K is Langmuir's constant) has been modified by Volmer, who obtained thermodynamically

$$C=\frac{k\eta}{1-2\eta\beta}$$

by using a modified equation of state $\pi(\Omega\text{-}\beta)=RT$, π being the surface tension and β van der Waals correction. In a previous communication Ganguli and Kar have deduced Langmuir's equation by statiscal mechanics and have attributed a physical meaning to Langmuir's constant. Thus

$$k=\frac{(2\pi MRT)^{\frac{1}{2}}}{\rho\,.\,N}e^{-\frac{a}{RT}},$$

where M is the molecular weight of the adsorbed substance N Avogadro Number, a=adsorption potential and ρ is a constant, which reduces to h for uni-molecular adsorption layers. 'a' has been identified with the heat of adsorption and also to the heat of sublimation of the adsorbed substance in several cases. This again corresponds with the maximum value of Polanyi's adsorption potential (for uni-molecular adsorption layers). The calculated values of K agree remarkably well with the experimental values. Since adsorption potential is equal to heat of sublimation in most cases, adsorption may be regarded as a process of condensation on the surface, the adsorbed substance being present as a layer of solid on the surface of the solid adsorbent. Volmer's method has been criticised because he combines thermodynamics with Kinetic theory, and a correction in the Gibbs-Thomson equation has been suggested. The modified equation is

$$a = \frac{1}{\left(\frac{1}{\eta} - \beta\right)} = -\frac{c}{RT}\frac{d\gamma}{dc},$$

where γ=surface tension, c the concentration, η and β have the same significance as before.

167. On the minimum electrical fields for a chemical change in a gaseous medium. Part I. The decomposition of nitrous oxide.

Shridhar Sarvottam Joshi, Benares.

In the now considerable literature on reactions produced under various types of electrical discharge, no quantitative data are available for the minimum potentials necessary to initiate chemical changes in gaseous medii. Such measurements are, however, necessary for any comprehensive theory of these reactions. The present paper gives results for the decomposition of nitrous oxide. The apparatus consisted of two glass tubes sealed together as in the familiar Siemens' ozoniser. The applied potential alternating at a given frequency is increased gradually till decomposition just set in. From this, and from a knowledge of the capacities of the various dielectrics in the reaction vessel, the intensity of the electrical field developed at the inner surface can be calculated for any given gas pressure. In a number of cases these values have been found to be less than the corresponding dielectric strengths, for which an explanation has been suggested.

168. The 'Corona pressure' phenomenon under electrical discharge in Siemens' ozoniser.

Shridhar Sarvottam Joshi, Benares.

It was observed that an instantaneous pressure rise of about 2 cms. was produced just on the application of a high alternating P.D. (about 48,000 volts r.m.s. per cm.) to a Siemens' ozoniser, filled with a number of well purified gases, and also such gaseous mixtures as did not change chemically under the influence of the discharge. The subsequent pressure rise was much slower. An equal, and a similarly instantaneous pressure fall, followed by a slower change, was noticed as the applied P.D. was switched off. The initial, 'Corona' pressure rise was found to increase regularly with the gas pressure at a constant P.D. over a limited pressure range. It varies similarly with, (i) the magnitude of the applied P.D., (ii) the ionisation current in, and (iii) the energy dissipated in the discharge space. Experiments are described in order to examine whether the initial pressure change is a thermal or an electrical effect.

169. Surface tension of sols in presence of electrolytes.

D. N. Chakravarti, Nagpur.

In series of previous papers it has been established that when small quantities of electrolytes are added to a sol there is an appreciable fall in the viscosity. In this paper it has been found that surface tension of sols increase when small quantities of electrolytes are added. This increase in surface tension is due to the increase in the charge on the sol by the adsorption of ions carrying the same charge as the sol. The increase in the charge on the sol is associated with the decrease in the hydration and viscosity and increase in the surface tension. On the other hand, when greater quantities of electrolytes are added the adsorption of ions carrying the opposite charge is more prominent than the adsorption of ions carrying the same charge, consequently the charge on the sol is decreased and hence the hydration will increase and surface tension decrease with increase in concentration of electrolytes until coagulation point is reached.

170. Surface tension of solutions of electrolytes of different concentrations and at higher temperatures.

K. P. Chatterjee, Allahabad.

Systematic investigation is being made in the surface tension of certain electrolytes, specially of saturated solutions of these. Apparatus for dealing with saturated solutions has been devised and the method of capillary rise is used.

With sodium chloride, the following results have been obtained.

Temperature.	Grams of sodium chloride with 100 grams of water.				Saturated solution of sodium chloride.
	0 gram.	10 grams.	20 grams.	30 grams.	
40°	69·5	72·3	74·8	77·6	79·3
50°	67·8	70·6	73·3	76·2	77·9
60°	66·0	68·8	71·6	74·6	76·6
70°	64·2	67·2	70·0	73·1	75·3
80°	62·4	65·3	68·3	71·4	73·8
90°	60·5	63·4	66·5	69·5	72·4

Surface-tension increases with increase of concentration in a practically linear manner, but the value of the increment is not the same at all temperatures. With increase of temperature, this value seems slightly to increase.

With rise of temperature, surface tension decreases in the usual way.

171. Viscosity of solutions of electrolytes of different concentrations and at higher temperatures.

K. P. Chatterjee, Allahabad.

A special apparatus has been devised for the investigation of viscosity of saturated solutions. Incidentally, solutions of other concentrations have also been investigated.

With sodium chloride the following results have been obtained.

Temperature.	Grams of sodium chloride with 100 grams of water.				Saturated solution of sodium chloride.
	0 gram.	10 grams.	20 grams.	30 grams.	
40°	·00658	·00758	·00950	·01160	·013245
50°	·00554	·00667	·00800	·00970	·011210
60°	·00475	·00568	·00690	·00840	·009556
70°	·00414	·00495	·00600	·00720	·008390
80°	·00365	·00440	·00535	·00640	·007413
90°	·00326	·00391	·00478	·00570	·006621

With greater concentration, greater becomes the increment of viscosity, but the values decrease with rise of temperature.

Various formulæ have been discussed.

Potassium chloride has also been investigated.

172. Aromatic disulphides and Sugden's parachor.

S. S. Bhatnagar *and* Balwant Singh, Lahore.

Parachors have been calculated for a number of aromatic disulphides from their surface-tension values, determined in the fused state. The observed parachors are in good agreement with those calculated from the atomic and structural constants of Sugden. From these values the constitution of the disulphides has been derived.

173. Mercaptans and Sugden's parachor.

S. S. Bhatnagar, Balwant Singh, *and* Ram Singh, Lahore.

Parachors have been calculated for a number of mercaptans from their surface-tension values, determined in the fused state. It has been shown that the mercaptans are not associated, while the corresponding alcohols and phenols are highly associated in the liquid state.

174. Influence of magnetic field on the adsorption of electrolytes by fine insoluble precipitates.

Mata Prasad *and* R. K. Valvekar, Bombay.

Adsorption of ferric chloride by ferric oxide, manganese dioxide and barium sulphate; of potassium permanganate by manganese dioxide, ferric oxide and barium sulphate; of copper sulphate by copper oxide, manganese dioxide and barium sulphate and of potassium chromate by lead chromate, ferric oxide and chromium oxide has been studied.

The results obtained show that the magnetic field influences the process of adsorption to a great extent. The amount of adsorption is either increased or decreased by the magnetic field according to the magnetic nature of the adsorbent and the substance adsorbed.

175. Influence of magnetic field on colloidal solutions.

MATA PRASAD *and* R. K. VALVEKAR, Bombay.

The influence of magnetic field on colloidal solutions of (i) positively and negatively charged ferric hydroxide (ii) negatively charged manganese dioxide and (iii) negatively charged antimony sulphide has been studied. In all these cases it has been found that sols get sensitised by the influence of the field.

176. The constitution of salts of cobalt in solution and their magnetic behaviour.

S. S. BHATNAGAR *and* A. N. KAPUR, Lahore.

Critical work on the magnetic properties of cobalt (from salts in various solvents) has been done and the theory of the change of the red solution of cobalt chloride to blue and *vice versa* is elucidated from magnetic properties.

177. A new magnetic balance and the magnetic susceptibilities of some allied diamagnetic compounds.

S. S. BHATNAGAR, K. N. MATHUR, *and* T. K. LAHIRI, Lahore.

A new magnetic balance involving several new principles has been designed. The suspended system has been made very light and small. The beam has been shortened to about 3 cms. as compared to 20 cms. or more in the balances of Curie and Wilson type. The electromagnet employed carries specially shaped pole-pieces with a third pole-piece fixed in the middle. This arrangement gives two non-homogeneous fields in each of which a sample of the specimen is suspended. Equal weights of the specimen are taken and are contained in two similar thin glass tubes. The gradients of the non-homogeneous fields are arranged in opposite senses and a couple is thus exerted on the specimen when the electromagnet is excited. Observations are taken by a ballistic method, *i.e.*, the electromagnet is excited for a definite short interval of time, with the same value of current each time and the corresponding "throws" of the beam are observed. This method very successfully overcomes the time and trouble involved in adjusting torsion heads to bring the specimen back to the initial position in the field. The balance has been used to determine magnetic susceptibilities of several closely allied diamagnetic compounds.

178. Investigations on the effect of crystalline structure on magnetic susceptibilities.

S. S. BHATNAGAR *and* R. N. MATHUR, Lahore.

In a paper communicated to Phil. Mag. in June last, a complete description of a new magnetic balance based upon the principle of interference of light has been given. Three allotropic forms of sulphur and the two isomeric modifications, red and yellow, of mercuric iodide were then investigated. A few changes, with a view to make the balance still more sensitive, have now been made in its construction and it has been used to determine the susceptibilities of the isomeric modifications of many other compounds, *e.g.*, the red and yellow modifications of mercuric oxide. Many substances have been crystallised from different solvents when they come out with different crystalline structures and their susceptibilities have been determined. As a result of this investigation, considerable light has been thrown on the mechanism of isomeric modifications.

179. Influence of light on the formation of some colloids.

MISS SHEILA ROY, Allahabad.

The hydrolysis of aqueous solutions of ferric chloride, ceric ammonium nitrate, chromic chloride, cobalt chloride and sulphate, nickel chloride and sulphate is markedly accelerated on exposure to light.

The measurements of electric conductivity, and pH values show that there are more hydrogen ions in the exposed solutions than those kept in the dark.

The extinction co-efficient measurements show that the light absorption is more marked with the exposed solutions than the unexposed ones. This behaviour is possibly due to the formation of the hydroxides of the respective metals in the colloidal state.

It can be concluded from my experiments that the formation of colloids by the hydrolysis of salt solutions is facilitated on exposure to light. When, however, the solutions are exposed for a long time the colloids formed are precipitated. This behaviour is specially observable with solutions of ferric and ceric salts.

180. Influence of light on colloids.

MISS SHEILA ROY, Allahabad.

In continuation of my experiments on the influence of light on colloids I have carried on further work on Kohlschütter's silver sols, silicic acid sol obtained from the hydrolysis of silicon tetrachloride, uranium ferrocyanide, and hydrated manganese dioxide and cadmium sulphide sols.

My results show that uranium ferrocyanide, manganese dioxide and cadmium sulphide sols when fairly pure are readily coagulated by light. Although silver salts are highly photo-sensitive, Kohlschütter silver sol is not markedly sensitive to light and coagulates after a very long exposure. Silicic acid sol coagulates only partially on prolonged exposure to light.

Specially purified sols of chromium hydroxide, ceric hydroxide, and zirconium hydroxide form jellies more readily in sunlight than in the dark.

An emulsion of fresh egg-white becomes unstable towards electrolytes on exposure to sunlight. On longer exposure the egg-white becomes yellowish coloured. An emulsion of egg-yellow becomes whitish yellow in sunlight and is partially coagulated.

181. Influence of OH· and H′ ions on the viscosity of the sols of silicic, vanadic, and tungstic acids.

N. R. DHAR *and* S. GHOSH, Allahabad.

It has been observed with more than 30 sols that their viscosity in the presence of an electrolyte is intimately connected with the electric charge on the colloid particles. Our experimental results as well as those of other workers in this line show that other things being identical, the smaller the electrical charge on a colloid, the greater is its amount of hydration and hence the greater is its viscosity. Thus it has been observed with several positively charged sols like $Fe(OH)_3$, $Al(OH)_3$, $Zr(OH)_4$, etc., that the viscosity goes on increasing and their stability towards their coagulation by electrolytes continuously diminishes as the process of dialysis is prolonged. The high viscosity of these unstable sols markedly diminish as soon as traces of a stabilising agent like HCl, Fe Cl_3, $AlCl_3$, $ZrOCl_2$, etc., are added to the sols.

It has been noted that the sols of silicic, vanadic, and tungstic are sensitized towards their coagulation in the presence of traces of an alkali, whilst smaller quantities of an acid make the sols stable. Larger quantities of an alkali render the sols stable and the greater amounts of an acid stabilise the sols. An explanation of this behaviour has been advanced, which assumes that the electrical charge of these negatively charged sols decreases on the addition of smaller quantities of an alkali and when larger amounts are added the electrical charge increases. On the other hand, traces of an acid increase the electrical charge on the colloids, whilst larger amounts decrease the electrical charge. Accordingly viscosity measurements were made with these sols with different quantities of $H^{\cdot}$ and OH' ions. Our results show that (1) the addition of traces of an alkali increase the viscosity of the sols and when larger amounts are added the viscosity decreases, and (2) the smaller quantities of an acid decrease the viscosity of the sols, whilst in the presence of greater amounts the viscosity increases. These results, therefore, support our view that the greater the viscosity of a sol the less the electrical charge on the colloid advanced in 1925.

It may be of interest to note in this connection that Pauli and Valko (Koll. Zeit 38, 289, 1926) found that the cataphoretic movement of colloidal SiO_2 is far less in the presence of salts of weak acids than in the presence of KCl.

182. On the colloidal behaviour of the sols of silicic, vanadic, tungstic, molybdic, antimonic, and telluric acids.

S. Ghosh, Allahabad.

(1) Sols of silicic, vanadic, tungstic, antimonic, molybdic, and telluric acids contain a part of the substances in the molecular condition and a part in the colloidal state when freshly prepared.

(2) Molecular silicic, vanadic, molybdic, tungstic, and antimonic acids gradually polymerise to bigger molecules with time and finally aggregate to form particles of colloidal dimensions. In the case of antimonic acid, this change is very rapid.

Thus molybdic acid, sol containing 1·550 grams of MoO_3 per litre when freshly prepared by the interaction of ammonium molybdate and hydrochloric acid, contains 47·8% of the substance in the molecular condition, which could pass through an ultrafilter. When kept for 120 hours at the room temperature the amount in the molecular condition decreases to 45·41%.

The viscosity of these sols increases, whilst the specific conductivity decreases when allowed to age.

(3) Telluric acid sol shows no change in the viscosity and specific conductivity with time.

(4) The sols of vanadic, silicic, tungstic, molybdic, and telluric acids are negatively charged. They are, however, sensitised towards their coagulation by electrolytes in the presence of small quantities of an alkali, whilst traces of an acid make the sols stable. Larger quantities of an alkali stabilise the sols and greater amounts of an acid render the sols unstable.

An explanation based on the existence of polymerised molecules in the sols has been advanced for this behaviour of the sols towards an acid and an alkali.

183. Adsorption by titanium dioxide sol.

L. S. Bhatia *and* S. Ghosh, Allahabad.

(1) A sol of titanium dioxide prepared by dropping $TiCl_4$ slowly into water at 18° cannot be completely freed from HCl by dialysis. It was found that the sol containing 15·2 grams TiO_2 per litre on prolonged

dialysis gradually became more viscous and as soon as the pH value was less than 4·1 the whole mass coagulated as a gelatinous precipitate.

(2) The sol prepared at 18° adsorbed appreciable amounts of anions from different sodium or potassium salts and they are adsorbed in the following decreasing order :—

$Fe(CN)_6''' > NO_2' > SO_4'' > Cl' > S_2O_3'' > Cr_2O_7'' > Br' > Fe(CN)_6'''' > IO_3' > CrO_4'' > OH'$, the amounts of adsorption are expressed in moles per gram adsorbent.

The coagulating powers of different anions are in the following decreasing order :—

$Fe(CN)_6'''' > Fe(CN)_6''' > SO_4'' > Cr_2O_7'' > CrO_4'' > OH' > S_2O_3'' > IO_3' > NO_2' > Cl' > Br'$.

(3) The above results show that (a) the generally accepted view that an ion, which is highly adsorbed also possesses a high coagulating power is not supported by experiments, and (b) there is no justification that the greater the valency and hence the coagulating power of an ion the greater is its adsorption.

(4) The amount of adsorption of OH' ions by titanium dioxide sol is very small. The high coagulating power of OH' ions is due to the removal of the stabiliser H' ions by OH' ions.

(5) Titanium dioxide sol adsorbs more of an anion than a cation, with the liberation of OH' ions which increases the pH value of the sol (the pH value of the sol was 3·9). In no case, pH value was greater than 7·3.

(6) We are of opinion that titanium dioxide (also known as titanic acid) possesses more of basic character than acidic.

(7) A sol of titanium dioxide containing 15·2 grams of TiO_2 per litre and prepared at 18° becomes stable towards it coagulation by electrolytes, shows a decrease in the specific conductivity and viscosity on ageing.

(8) On the other hand, a sol of titanium dioxide containing 10·2 grams of TiO_2 per litre and prepared at 55° does not show any change in stability and the specific conductivity and viscosity increase very slightly on ageing.

(9) We are of opinion that a sol of titanium dioxide prepared in the cold becomes stable on keeping as free HCl present in the sol gradually acts on TiO_2 forming $TiCl_4$, which gives out $Ti^{\cdot\cdot\cdot\cdot}$ ions that are completely adsorbed by the sol and hence possess greater stabilising influence than $H^{\cdot}$ ions. This is not possible in the case of the sol prepared at 55°, as it is well known that chemical activity as well as the power of adsorption of a precipitate is considerably diminished when prepared in the hot condition.

184. Solubility of silver hydroxide and formation of silver sol at different temperatures.

RAI PARMATMA PRASAD MATHUR, Allahabad.

Careful experiments carried on with freshly prepared and purified silver hydroxide show that a saturated solution at 31° contain 0·0245 grm. Ag per litre of solution. The solubility markedly increases with the rise in temperature.

The amount of Kohlschütter silver sol obtained by passing hydrogen through saturated solutions of silver hydroxide at 50°, 60°, 70°, and 80° has been determined. The amount of silver sol formed increases with the increase of temperature. Contrary to the observation of Kohlschutter it has been observed that the sol is quite stable at 70° and 80°.

185. On the critical potential of ferric hydroxide sol and the influence of its ionic environment on its rate of migration in an electric field.

J. N. Mukherjee *and* M. M. Biswas, Calcutta.

The charges of ferric hydroxide sol at different dilutions at critical concentrations of electrolytes are being measured. The simultaneous determination of the transport numbers as also of electro-osmotic flow through pure ferric hydroxide percipitate are being carried out. The results are expected to reveal many points of interest. Also the influence of ionic environment on the rate of migration of the sol in an electric field is being studied.

186. Measurement of charge of arsenious sulphide sol in presence and absence of arsenious oxide and hydrogen sulphide.

J. N. Mukherjee *and* S. G. Rajkumar, Calcutta.

Further experiments on the stability of arsenious sulphide sol in presence and absence of arsenious oxide and hydrogen sulphide with different electrolytes have been carried out. Influence of constitution of the sol on such measurements have been pointed out from publications in this Laboratory (Mukherjee and Raichoudhuri and Bhattacharya, Journ. Ind. Chem. Soc., **5**, 738, 1928). Also simultaneous measurements of transport numbers and electro-osmotic flow through pure As_2S_3 are in progress.

187. The effect of dialysis and centrifugal action on the cataphoretic velocity of copper ferrocyanide hydrosol.

S. G. Choudhury.

The hydrosols were prepared by precipitation of copper ferrocyanide, and subsequent peptisation with potassium ferrocyanide and then as dialysis was proceeded with, the cataphoretic velocity of the sol was measured from time to time. On dialysis, the cataphoretic velocity of a particular sample of sol showed increased value, though the sol became much more unstable. The current idea therefore, that the density of electrical charge decreases on dialysis thereby making the sol unstable is not correct. Subsequently it has also been shown that depending on the amount of precipitate peptised and the amount of ferrocyanide present. the cataphoretic velocity increases or remains constant. No decrease has been found up to the interval allowed for dialysis.

As a result of centrifugal action the cataphoretic velocity decreases, and the sol becomes unstable.

188. The effect of sugar on the cataphoretic velocity of copper ferrocyanide hydrosol.

S. G. Chaudhury *and* N. P. Chatterjee.

1. In presence of potassium chloride with or without sugar, the cataphoretic velocity at first decreases, then increases. There is another decrease at high concentrations of potassium chloride, except in the case of 10% sugar, where the colloid coagulates.

2. In presence of sugar alone, the cataphoretic velocity at first decreases rapidly but the rate of variation of the velocity with higher percentage of sugar is small.

3. The rate of variation of the velocity with increasing concentrations of potassium chloride is smaller, the higher the percentage of sugar taken.

4. With barium chloride alone, the velocity continually decreases: in presence of 2.5% sugar, the same behaviour is observed though the initial drop is low and the final drop is high compared to the velocities observed in presence of barium chloride alone. *In the case of* 5% *and* 10% *sugar and with barium chloride we find an initial increase in the cataphoretic velocity at low concentrations of the electrolyte.*

189. The influence of the constituent ion on the stability of uranium ferrocyanide sol.

N. P. CHATTERJEE.

Uranium ferrocyanide sol in a high state of purity has been prepared. Its coagulation has been carried out in presence and absence of potassium ferrocyanide and uranium nitrate.

190. Liesegang rings in colloidal solutions.

R. N. MATHUR *and* K. G. MATHUR.

Formation of clear and well-defined Liesegang rings has been observed by diffusing electrolytes into gels of agar-agar and gelatin impregnated with sols of CdS, Sb_2S_3, and eosin. Completely dialysed sols and thoroughly washed gelatin and agar-agar have been used. The effect of the concentrations of the electrolyte and the sol on the formation of rings has been studied. The results are expected to throw light on the theories of Liesegang ring formation. Further work on the sols of Au, Ag, and $Cu(OH)_2$ is in progress.

191. Stability of organo-sols.

N. A. YAJNIK *and* B. S. CHANDAR, Lahore.

In the present investigation an attempt has been made to study the conditions affecting the stability of organo-sols, such as zinc in acetone and copper in ethyl alcohol. It has been found that the stability of these systems is affected by the addition of electrolytes the same way as of the hydrosols. The order in which coagulation takes place by the addition of the electrolytes only is in accordance with the valency rule. The addition of non-electrolytes is found to bring about a sensitisation of the organo-sols towards the addition of electrolytes.

192. Effect of dilution of a colloid on electrolyte concentrations.

A. M. PATEL.

The effect of dilution of colloids on electrolyte concentrations has been recognised long ago. In a series of papers, Dhar, Ghosh, and Sen have studied the changes in the concentrations of different sols when coagulated by different electrolytes. From the results, Dhar and Ghosh have formulated a general dilution rule which states that with the dilution of a colloid, the amount of an electrolyte required to coagulate the colloid becomes less and less provided that the sol does not appreciably adsorb the ions carrying the same charge as the colloid from the precipitating electrolyte.

With a view to test the validity of the above generalisation, experiments on the coagulation of thorium hydroxide sol of—different concentrations and dialysed for different periods (*i.e.*, containing different amounts of the peptising agent, *viz.*, HCl) were carried out.

From the results obtained, it is found that the dilution rule holds good in case of thorium hydroxide sol irrespective of the amount of the peptising agent present in the colloid. However, it is observed that with increase in the purity of the sol, the difference in the electrolyte concentrations required to coagulate the sol increases rapidly with dilution of the colloid. This is in accord with the fact that the dilution rule holds good only in those cases where the adsorption of the ions carrying the same charge as that on the colloid is negligible in comparison to the adsorption of the precipitating ions.

From the results, one is inclined to believe that the nature of the electrolyte as well as the relative adsorption of the stabilising and precipitating ions are mainly responsible for varying amounts of the electrolyte on the dilution of a colloid.

193. Effect of non-electrolytes containing different hydroxy groups on the peptisation of thorium hydroxide in presence of an excess of caustic soda.

G. M. Nabar *and* A. M. Patel.

From the work on the peptisation of thorium hydroxide by non-electrolytes carried out by one of us (Patel) it was suggested that greater the number of the hydroxy groups present in a non-electrolyte, greater was its peptising power.

With a view to test the above suggestion the effect of non-electrolytes containing different numbers of hydroxy groups on the peptisation of thorium hydroxide was studied under different conditions.

It is found that greater amounts of non-electrolytes are required to peptise greater amounts of thorium hydroxide, when the amount of caustic soda and the volume of the system are kept constant.

It is observed that when the amount of thorium hydroxide and the total volume of the system are kept constant, less amounts of the non-electrolytes are required with increasing amounts of caustic soda.

When the amounts of thorium hydroxide and caustic soda are kept constant and the volume of the system is changed, it is found, that in cases of cane-sugar and glucose, the amounts required decrease while in those of ethylene glycol, glycerol, fructose, and lactose, the amounts increase with the increase in the total volume of the system.

It is found that the peptising power of non-electrolytes increases with the increase in the number of their hydroxy groups. Fructose is, however, found to be an exception.

194. Adsorption of the chloride and the sulphate ions by thorium hydroxide sol in the absence and presence of non-electrolytes.

N. V. Karekar *and* A. M. Patel.

It is a well-known fact that adsorption, besides some other factors, is mainly responsible for the coagulation of colloids by electrolytes The effect of non-electrolytes on their stability is also attributed to their adsorption by the colloids.

Experiments were carried out to study the adsorption of the chlorides of the alkali metals and the sulphates of the mono-, bi-and tri-valent metals in the absence and presence of some non-electrolytes (*viz.*, methyl, ethyl, and propyl alcohols) by thorium hydroxide sol with decreasing amounts of the peptising agents, *i.e.*, with progress of dialysis.

It is found that the non-electrolytes cut off the adsorption of all the chlorides in all cases and of the sulphate ions of the mono- and bi-valent metals while the adsorption of the sulphates of the trivalent metals is increased in the presence of non-electrolytes. The order of their adsorption was not the same as that of their coagulating power showing, therefrom, that it is wrong to assume that coagulation and adsorption go hand-in-hand. From the results, it can, at once, be seen that the systematic study of the adsorption of the electrolytes by colloids (and not by the precipitated substances) is bound to shed a flood of light on the mechanism of coagulation.

195. Kinetics of the coagulation of arsenious sulphide sol.

SHRIDHAR SARVOTTAM JOSHI *and* RAMESH S. M. PRABHU, Benares.

The paper contains a critique of the various existing methods of measuring the coagulation velocity of the colloids. In this work the percentage coagulation produced in a finite time has been determined directly by an analysis of the coagulum at different temperatures, and with varying initial concentrations of the colloid. Regular curves are observed relating the colloid concentration with time, at successive stages during coagulation, and the corresponding viscosity of the system. The results are discussed in the light of Smoluchowski's equation.

196. Coagulation of manganese dioxide sol. Part I. The influence of temperature, and of the colloid and electrolyte concentration.

SHRIDHAR SARVOTTAM JOSHI *and* T. S. NARAYAN, Benares.

Results are given for the coagulation of the above sol over a wide range of temperature and of the concentrations of the precipitating electrolytes, as well as of the colloid material, the last containing a very small quantity of KOH. Interesting results are observed regarding the temperature effect. The coagulation rate diminishes continuously with temperature till about 30°C, and then increases as the temperature is increased. A departure from the Smoluchowski's equation is observed in the results for the influence of the concentration of the coagulating electrolyte.

197. The coagulation of the manganese dioxide sol. Part II: The behaviour of the electrolyte free sol.

SHRIDHAR SARVOTTAM JOSHI *and* T. S. NARAYAN, Benares.

The manganese dioxide sol prepared in the familiar J. Cuy's method contains a small amount of KOH. Attempts at removing this by dialysis result in the instabilisation of the colloid, except when the process is carried out at temperatures well above 60°C. A new method which gives an electrolyte free sol has been developed. It is to carry out the dialysis with a negative potential applied to the dialysing septum. The stability period of the resultant sol has been observed to increase as the magnitude of the applied potential is increased. This sol is also found to be markedly sensitive towards electrolytes, as well as to any solid heterogenities that might be introduced in the system.

198. Studies on the effect of ultraviolet light on colloids, Part II.

PANNA LAL *and* P. B. GANGULY, Patna.

In a previous paper (Jour. Ind. Chem. Soc., 1929, 6, 547) the coagulation of a number of colloidal solutions by ultraviolet light has been studied. A further series of colloids have been prepared in which the usual charge on the particles has been reversed, and exposed to ultraviolet light. It has been found that both positively as well as negatively charged colloids are coagulated equally well by light. These results do not support the conclusion of Crowther (Phil. Mag., 1927, 4, 325; *ibid.*, 1929, 7, 86) that the coagulating action of radiations is restricted to negatively charged colloids only.

199. Studies on the effect of ultra-violet light on colloids.—Part III.

P. C. SINHA *and* P. B. GANGULY, Patna.

A series of peptised colloidal solutions have been prepared by using sodium soaps, sodium lysalbate, sodium protalbate, and gelatine as the stabilising agents and exposed to the action of ultra-violet light. Coagulation occurred in a majority of cases. Solutions of the peptising agents themselves were also exposed individually to ultra-violet light. Measurements of pH values, conductivities, and in certain cases viscosities, of the exposed and the unexposed solutions indicate considerable chemical changes, showing that the coagulation of the peptised colloids is primarily due to the chemical decomposition of the peptising agents by light.

200. The emulsifying action of colloidal sulphur.

BASRUR SANJIVA RAO, Bangalore.

When a very dilute solution of iodine or bromine in benzene is shaken with an excess of an aqueous solution of hydrogen sulphide the benzene layer becomes turbid. The turbid liquid clears on treatment with dehydrating agents but regains its turbidity on shaking with water.

As a result of systematic investigation it has been concluded that the turbidity is due to an emulsion of water in benzene the emulsifying agent being a colloidal form of sulphur, which is hydrophilic and at the same time stabilised in benzene by persulphides of hydrogen or halides of sulphur.

201. On 'activated' charcoal.

S. P. RAICHOUDHURI, Calcutta.

1. The adsorption of inorganic acids by charcoal has been found to be purely molecular.
2. Adsorption of electrolytes by various kinds of activated charcoal has been carried out. The results have been discussed from the point of view of current theories of adsorption.
3. Effect of heating the charcoal at different conditions has been studied. It is found that the charcoal is most active when heated in the atmosphere of pure nitrogen.
4. The so-called negative adsorption by charcoal has been found to be due to removal of water by charcoal.
5. Very pure form of animal charcoal has been found to be positively charged which on the addition of very small concentrations of hydrochloric acid becomes negatively charged.

202. Preparation of some hydroxide and other inorganic jellies.

SATYA PRAKASH *and* N. R. DHAR, Allahabad.

1. The conditions of the formation of various new jellies have been investigated.

2. We have prepared hydroxide jellies of iron, chromium, aluminium, tin, and zirconium by the addition of sodium acetate to chlorides of nitrates of these metals; wherever it was found necessary, various amounts of ammonium sulphate and ammonia have also been added but all these jellies have been obtained in acid medium. It has been shown that for the preparation of zirconium and ferric hydroxide jellies, no addition of ammonia is necessary while in the case of chromium and tin, large quantities of ammonia have to be added before obtaining a jelly. In the case of aluminium, only a small amount of ammonia yields a jelly. The nature of these jellies has also been studied.

3. We have also obtained new jellies of chromic tungstate, zirconium molybdate, zirconium borate, ceric arsenate, and ceric borate by dialysing the mixtures of chromic chloride, zirconium nitrate, and ceric ammonium nitrate with sodium tungstate, potassium molybdate, potassium arsenate, and borax solutions, and coagulating the sols thus obtained by various electrolytes.

203. Soap gels in alcohol.

S. N. Banerji *and* S. Ghosh, Allahabad.

Soap gels of different concentrations were prepared in alcohol with sodium palmitate and the phenomenon of hysteresis in the sol-gel transformation was studied. It was found that as the concentration of the gels increased the degree of hysteresis passed through a minimum. The process of gelation resembles the crystallisation from a super-cooled solution. Thus the setting of sodium palmitate gels in alcohol is remarkably favoured by shaking and by inoculating the sol with already formed gels. Similar results were obtained by Hardy (Proc. Roy. Soc., 87, 29, 1912) with azomethine gels and Baratte (compare Hardy, *loc. cit.*) with gelatin gels. Our results with sodium palmitate gels of different concentrations on the phenomenon of hysteresis on the sol-gel transformation can be easily explained on this view.

It may be of interest to note that several years ago Tammann (Z. Physik. Chem., **25**, 441, 1898) observed that at very low temperatures that substances like molten phosphorus, azobenzene, benzophenol, etc., lose all capacity of crystallisation and maintain their glassy character. These results are also in support of our view advanced with soap gels.

204. The influence of the concentration of coagulating electrolytes, time and temperature on the syneresis of some inorganic jellies.

Satya Prakash, Allahabad.

1. The phenomenon of syneresis of the following jellies has been studied from various view points:

Ponceaux-red, ferric phosphate, ferric arsenate, chromium arsenate, vanadium pentoxide, zirconium hydroxide, zirconium molybdate. zirconium borate, ferric borate, and manganese dioxide.

2. It has been observed that greater the concentration of the coagulating electrolyte, the greater is the amount of syneresis, and this has been explained on the basis of the influence of electrolytes on hydration and agglomeration tendency of particles forming the net-work of the jelly.

3. It has been observed that the syneresis starts a short time after the setting of the jelly and the amount of syneresis increases with time up to a limiting value but after this limit the rate of increase diminishes.

4. The influence of temperature on the syneresis of these jellies has also been investigated. It has been observed that the amount of syneresis is markedly increased at higher temperatures. Experiments have been

carried on at three temperatures, 30°, 50°, and 70°C and it has been found that the temperature co-efficient between 30° and 50° is much less than that between 50° and 70°.

5. In many jellies, such as those of iron, chromium and aluminium hydroxides and arsenates, phosphates and molybdates of thorium, only very little syneresis has been observed when kept for months but the jellies of stannic hydroxide, borate, and tungstate synerise readily.

205. On the development of acidity in soils.

J. N. MUKHERJEE *and* H. K. SEN, Calcutta.

The nature of electrometric titration curves of sparingly soluble acids such as cinnamic acid, as also silicic acid gel and aluminium hydroxide sol are being studied. The temperature co-efficient of acid liberation by hydrated and dehydrated silica in contact with different electrolytes has been investigated and the results discussed from the theoretical standpoint.

206. The optimum conditions for the formation of silica gel from alkali silicate solutions. Part II.

R. C. RAY *and* P. B. GANGULY, Patna.

In a previous paper (reported to the Science Congress last year), the optimum conditions for the formation of silica gel from alkali silicate solutions, where the ratios of the alkali oxide to silicon dioxide were as 1 : 1 and 1 : 2, were studied. The present paper describes further extension of the work, and the conditions of gel formation have been examined in the case of sodium silicate solutions containing higher ratios of silicon dioxide, the highest being the case where the ratio Na_2O/SiO_2 is equal to 4.

The gel formation by the action of ferric chloride on sodium silicate solutions has been further investigated by measurements of heats of reactions.

207. Adsorption of ions by hydrated silica, alumina, and aluminium silicates.

A. NAGARAJA RAO, Bangalore.

The ionisation of amino-acids giving rise to restricted quantities of both OH and H ions has been known to be the cause for the maintenance of a fairly uniform pH value in body fluids. The complex alumino-silicates seem to be responsible for a similar adjustment of pH values in soil. Experiments are in progress to explain from the point of view of adsorption the complete role played by these complex alumino-silicates in maintaining the pH value in soils.

208. Adsorption of alkali sulphites by silicic acid gel.

SARJU PRASAD, Benares.

Results are given for the adsorption of sodium sulphite from its solution on the gel which was prepared according to the method elaborated by Patrick and Mcgarack (Journ. Amer. Chem. Soc., 1920, *212*, 946) in an atmosphere of nitrogen. The temperature was varied over a wide range, and the influence of an initial addition of sodium sulphate was studied. The results are found to be in good agreement with the Freundlich's equation for the adsorption isotherm.

209. Condition of sparingly soluble substances when formed in presence of a gel: Lead iodide in agar-agar and gelatine.

M. D. PANDAY *and* A. C. CHATTERJI.

In a recent paper (Trans. Faraday Soc., 1928, *24*, 461.) Bolam and Mackenzie came to the conclusion that PbI_2 in agar-agar remains in a supersaturated condition. It has been emphasised and shown experimentally in a number of previous papers (Jour. Ind. Chem. Soc., 1928, *5*, 175; Trans. Faraday Soc., 1926, *72*, 23; Koll. Zeit., 1926, *40*, 97; 1925, *35*, 2, 89) that sparingly soluble substances when formed in presence of a gel exist mainly in the colloidal state. Bolam and Mackenzie's results have been scrutinised and it has been shown that from their own experimental results it is difficult to accept their conclusions.

In this paper the electric conductivity of PbI_2 in agar-agar and ash-free gelatine has been measured. Agar-agar was well washed first with distilled water and finally with conductivity water till the conductivity of the supernatant liquid did not increase. Agar-agar was tested to be free from sulphate ions.

The results obtained are in complete harmony with our former views. In fact, the conductivity of lead iodide in agar-agar is less than the conductivity of PbI_2 of an equal concentration when freshly precipitated in conductivity water, proving thereby that lead iodide is more soluble in water than in an agar-agar sol.

210. Ignition points of the electrolytic mixture $(2H_2+O_2)$ and (H_2+O_2).

H. K. SEN *and* SUKHAMOY CHATTERJEE, Calcutta.

Since the publication of a paper by one of us and H. N. Chatterjee (J. Indian Chemical Society, 1929) on the ignition temperature of some inflammable gases, the rather unexpected lower ignition point of the electrolytic gas mixture has led us to investigate more accurately this point. As the reading of very small current differences by ammeters might vitiate the results and inference, we used the potentiometric method for accurately finding the current strengths The following results were obtained with soap bubbles of 50 c.c. capacity:—

Composition of gases.	Bridge reading.	Current in ampere.	Difference.
Hydrogen : Oxygen			
2 vols. : 1 vol.	22·7 cm.	3·36414	0·0741
1 vol. : 1 vol.	23·2 cm.	3·43824	

211. Esterification in mixed solvents.

B. V. BHIDE.

Esterification of phenyl-acetic acid in amyl alcohol-benzene mixtures at constant acid-catalyst concentration has been studied at 30°C. with hydrogen chloride as catalyst. The velocity co-efficient-composition curve shows a well marked minimum at 50% benzene concentration. With 90% benzene, the co-efficients are higher than in pure alcohol. Surface-tension curves of mixtures of benzene and amyl alcohol show no discontinuity.

212. Physical properties of acetates in anhydrous acetic acid. Part I.

B. V. BHIDE.

Viscosities and densities of solutions of Li, Na, K, NH_4, Co, Hg, Pb, Ba, and Mg have been determined. At 0·5N concentration the viscosity increment follows the order Ba $<$ K $<$ Mg $<$ Pb $<$ Na $<$ Li. The viscosity increment increases with increasing atomic weight more rapidly than metals of low atomic weight. Acetates of Ca, Cd, and Mn are insoluble in acetic acid. Mercury and cobalt acetates are sparingly soluble. Further work is in progress.

213. On Rhythmic Structures.

P. B. GANGULY *and* D. N. GHOSE, Patna.

Rhythmic structures in capillary spaces in the absence of a gel have been obtained by Notboom (Kolloid-Z., 1923, **32**, 247), Brodersen (Kolloid-Z., 1924, **35**, 21), and others. Further experiments have been performed on a large series of reacting pairs of solutions, and it is found that the phenomenon is a general one with nearly all precipitates, crystalline or colloidal. These structures are obtained when two drops of the re-agents, separated by a paraffin line on a clean glass plate, are covered by another similar plate, and the two advancing surfaces are just caused to meet by slight movement of the top plate. In most cases, although the reaction is continuous the final structure is found to be periodic. The cause of formation of these structures has been discussed in the light of some of the theories advanced to explain the well-known Liesegang phenomenon.

214. Importance of the oceanic salt deposits to geologists.

S. K. RAY, Dhanbad.

The sea water contains components, chlorides, sulphates, etc., which, on the drying up of the ocean basin, separate into various mineral phases due to reactions similar to what have been enumerated in case of the magma. Moreover, there seems to exist certain definite mathematical relation between the ionic numbers of the principal elements contained in the sea salts.

215. The densities, compressibilities, and dielectric co-efficients of silanes.

G. GUNDU RAO, K. L. RAMASWAMY, *and* H. E. WATSON, Bangalore.

Mono- and di-silanes have been prepared by the action of hydrochloric acid on magnesium silicide and their separation and purification have been effected by fractional distillation. Values for the densities have been obtained at room and solid CO_2 temperatures. Approximate values of the compressibilities have also been determined in order to evaluate the electric moment from the values of the dielectric co-efficients. An apparatus permitting the simultaneous determination of density and compressibility at different temperatures has been employed. The dielectric co-efficients of the two gases have been measured by the heterodyne method at high frequency at different temperatures.

216. Alcoholysis in Mixed Solvents.

Z. H. PATEL, Bangalore.

The action of methyl and ethyl alcohols on the esters of propionic and butyric acids has been studied dilatometrically at two temperatures in the presence of benzene using hydrochloric acid as a catalyst. The mean temperature co-efficient between 30° and 40° is 1·84.

The velocity coefficients reduced to the same quantity of alcohol increase with the amount of benzene. Reactions with 99 per cent. alcohol-benzene mixtures have also been conducted.

Experiments tried with different concentrations of the catalyst show the velocity coefficients to be proportional to the concentration of the catalyst even in presence of fifty per cent. of benzene. It is shown from conductivity data that the hydrogen ion is not the only catalytic agent but that the undissociated molecule also acts as a catalyst.

It is suggested that a change in the degree of association of the alcohol on addition of benzene may be a factor in changing the velocity coefficient.

217. The solidification points of capric and stearic acids and their mixtures.

Z. H. PATEL, Bangalore.

The freezing points of a complete range of mixtures of capric and stearic acids have been determined. The curve obtained by plotting percentage composition of the acids against freezing points does not show any breaks, indicating thereby no tendency to compound formation. The eutectic mixture which melts at 26·65° contains 90 per cent. of capric acid.

218. The conductivity of soaps in alcoholic solutions.

B. S. V. K. VITTAL.

The sodium and potassium soaps of pure oleic and stearic acids have been prepared and the conductivities of their solutions in aqueous alcohol of varying concentrations ranging from 0—100 per cent. of alcohol determined.

Viscosity measurements of the solutions have also been made and the curves connecting molecular conductivity with dilution studied.

219. The heats of transition of triglycerides.

M. M. RAMA RAO *and* S. K. KULKARNI JATKAR.

A method has been developed for measuring latent heats of fusion by means of a twin calorimeter to which heat is supplied at a known steady rate, the time for fusion being determined. This has been used for measuring the heats of fusion of the two forms of tristearin, the difference corresponding with the heat of transition.

A method also employing a double calorimeter has been applied to the determination of the heats of solution of the two modifications of tripalmitin and tristearin in several organic solvents. The difference in the heats of solution of the two forms is constant and equal to the difference in the latent heats, indicating that in solution these bodies assume the same form.

220. Adsorption isotherms in non-aqueous systems.

J. G. KANE.

A study of the system toluene-acetic acid with respect to its adsorption isotherm has been made for three adsorbents, activated silica and animal and sugar charcoals. The results obtained indicate that the preferential adsorption of either of the components depends on the nature of the adsorbent and its activity. With animal charcoal, toluene is preferentially adsorbed at low toluene concentrations and acetic acid at toluene concentrations above 60 per cent.

With sugar charcoal toluene is preferentially adsorbed at all concentrations and with silica the reverse phenomenon is observed.

221. The systems sulphuric acid—methyl ether—propyl ether.

N. G. GAJENDRAGAD.

Pure sulphuric acid was mixed with methyl and propyl ethers and the electrical conductivity, viscosity, surface tension and density of the mixtures were measured in a specially designed cell. The data are discussed from the point of view of intermediate compound formation.

222. Fusibility of mixtures of sodium carbonate with calcium carbonate and with lime.

R. C. RAY *and* V. DAYAL, Patna.

Mixtures of carbonates of sodium and calcium fuse by rapidly heating them at temperatures below 700°. The maximum fusibility is obtained with mixtures containing 5–6% of calcium carbonate. The fusibility of sodium carbonate and calcium carbonate mixtures is found to be greater than sodium carbonate and lime mixtures. The fusion of sodium carbonate and calcium carbonate mixture is accompanied by partial decomposition of the calcium carbonate, especially in an atmosphere free from carbon dioxide. By prolonged heating practically the whole of carbon dioxide is lost by the calcium carbonate, and the fusibility of the resulting mixture is considerably diminished.

223. The systems, $KMnO_4$—KBF_4—H_2O and $KClO_4$—KBF_4—H_2O.

R. C. RAY *and* K. K. CHATTERJI, Patna.

Zambonini (Z. Kryst. Min., 1905, **41**, 60) and Barker (Jour. Chem. Soc., 1912, **101**, 2484) have stated that potassium fluoborate and perchlorate are isomorphous. Zambonini (Atti. R. Accad. Lincei , 1922, [V], **31**, ii, 67) has also found a slight miscibility, up to 0·4 per cent. of potassium permanganate with the fluoborate but on the permanganate side the miscibility was found to be practically zero. We have found, however, that when either a crystal of potassium chlorate or a crystal of potassium permanganate is suspended in a saturated solution of potassium fluoborate overgrowth crystals are formed in both cases. In order to determine whether mixed crystals (solid solutions) of limited composition only or double salts are formed, a phase-rule study of the above-mentioned systems has been made.

224. The Ternary System K_2SO_4—$CdSO_4$—H_2O at 25°C.

K. L. MALHOTRA, H. D. SURI, *and* A. R. SHARMA.

(1) The usual Schreinemakers diagram (at 25°C) shows an increase in the solubility of K_2SO_4 on the addition of $CdSO_4$ up to the triple point.

This indicates the formation of the double salt in solution over a considerable range.

(2) The solubility curve at 25°C indicates a small increase in the solubility of $CdSO_4$ on the addition of increasing amounts of K_2SO_4. This is not traceable in the triangular diagram.

(3) The addition of K_2SO_4 to a saturated solution of $3CdSO_4\ 8H_2O$ causes the separation of an anhydrous double salt, $CdSO_4$, K_2SO_4.

225. The System $(NH_4)_2SO_4$—$CdSO_4$—H_2O at 25°C.

K. L. Malhotra *and* H. D. Suri.

(1) The solubility of $(NH_4)_2SO_4$ is decreased by the addition of $CdSO_4$, while the solubility of $CdSO_4$ is increased by the addition of the other component.

(2) The conjugation lines intersect within the triangle representing the ternary system, confirming the separation of the stable double salt $(NH_4)_2SO_4$, $CdSO_4$, $6H_2O$, c.f. $MnSO_4$, Na_2SO_4, $2H_2O$ reported by Caven and Johnston (J. Ch. Soc., 1928, 2506).

(3) The solubility curve at 25°C shows the existence of this stable double salt when the solution contains from 0·13 to 3·63 molecules of $CdSO_4$ per molecule of $(NH_4)_2SO_4$.

226. Further experiments with the calomel electrode.

K. K. Kumar, Calcutta.

Experiments with the calomel electrode and hydrochloric acid and potassium chloride at very low concentration have been continued.

Section of Zoology.

President:—Dr Sunder Lal Hora, D.Sc. (Punjab), D.Sc. (Edin.), F.R.S.E., F.L.S., F.Z.S., F.A.S.B.

Presidential Address.

The Value of Field Observations in the study of Organic Evolution.

> "Zoology, like all other branches of Natural Science, has had two lines of progress, observation, and generalisation. Without accurate and detailed knowledge of the facts and phenomena of animal life and structure, all theories of classification or of origin are so much idle speculation : in the absence of the philosophic spirit suggesting hypotheses of greater or less magnitude, the mere accumulation of facts is an empirical and barren study." (Parker and Haswell, 1910, p. 668.)

For a biologist there is no problem of greater interest than the study of Organic Evolution. No one doubts to-day that evolution is a fact, but how it is caused is the main problem that still awaits solution. Several theories have been advanced to explain the method of organic evolution, but none has met with unanimous scientific approval, and though each theory explains a certain number of facts, not one is sufficiently comprehensive to cover them all. To tackle this evasive problem several methods have been devised and considerable progress has been made along each. At the present day, however, there is an increasing tendency to advocate the experimental method in preference to the observational method of the older naturalists. According to Professor Julian S. Huxley it is unthinkable that any attempt should be made "to raise any theory of the *method* of evolution on observational data alone," but such workers evidently seem to forget that the theory of "evolution is a philosophy of wild nature. It relates to animals living under natural conditions, outside the domain of the laboratory worker and in that of the field naturalist. The laboratory-trained zoologist lacking in field knowledge often shows a singular incapacity for understanding the importance of evolutionary factors which experience in the field, more especially tropical experience, drives home" (Kerr 1926, p. 9). Professor D. M. S. Watson in his presidential address to the Zoology Section of the British Association for the Advancement of Science last year concluded that "the present position of zoology is unsatisfactory," and that the "data which we have accumulated are inadequate". In Professor Watson's opinion "the experimental method rightly used will in the end give us, if not the solution of our problem, at least the power of analysing it and isolating the various factors which enter into it". To me, however, it seems that the inadequacy of our accumulated data is mainly due to the fact that the study of the environment has not kept pace with the study of the organism. It is impossible to understand the life mechanism of an organism without an adequate, if not thorough, knowledge of the numerous factors that influence its life in an environment, for " Organism and environment must be thought of as a unity, as interlocked and fitted closely to form that harmony which is Nature and life" (Allen 1929, p. 841). It follows, therefore, that the first requisite in the study of evolution is to understand the true relationship between an organism and its habitat. Once this relationship has been established, experiments in the laboratory may be very instructive and useful, but if laboratory observations precede field observations care must be taken that they do not lead to any unjustifiable conclusions for after all—" evolution is a philosophy of wild nature".

To my mind the best method of studying the correlation that exists between an animal organisation and its habitat is to make direct observations, to supplement them afterwards by making experiments in the field under natural conditions and then, if need be, to subject the organism to experiments in the laboratory. The late Dr. N. Annandale was a great believer in observational method and his Presidential Address to the Science Congress and a number of his other contributions are sufficient to show his appreciation of its immense value. I had the good fortune to work under the guidance of this great teacher for a number of years both in the field and in the laboratory and as an humble tribute of appreciation of his teaching I have chosen as the subject of my address "The Value of Field Observations in the study of Organic Evolution."

For a period of ten years I have been interested in studying the structural modifications undergone by the fauna of torrential streams and in this connection I have made extensive observations, recorded in a number of papers, on the torrential fauna of this country. You will excuse me, therefore, if I give here a simple, but very instructive example, from this fauna to illustrate my subject.

All of you know that a fish is capable of maintaining its level in water without any great exertion on its part with the help of its air-bladder, which is a buoyancy-giving structure and serves as a hydrostatic organ. Now the problem of maintaining equilibrium at the various strata of the depth of a lake is different from that of remaining at the bottom. In both cases, the animal has to react to the mechanical effect of gravity; in the former, the desired result is attained by the production of buoyant structures, whereas in the latter the object is achieved by the reduction or total absence of such devices. In a torrent, the greatest necessity for life for an animal is to remain as close to the substratum as possible and to meet this demand the air-bladder is greatly reduced in fishes of this habitat. A buoyant fish with a well-developed bladder has no chance to resist a rushing torrent whilst frolicking about in this habitat is a dangerous pastime. Now suppose the fishes of the rapids were compelled to live in a lake, they would be uncomfortable in their attempt to rise to the surface for their heavier build would tend to keep them close to the bottom ; they would not be at home in their new surroundings unless their bladders developed again to make them buoyant. I shall illustrate this hypothesis with examples furnished by loaches of the genus *Nemachilus*. Most of you are, no doubt, aware that the Nemachili are commonly found in the hill-streams of India and Burma and that only a few of them are found in slow-running or stationary waters at high altitudes.

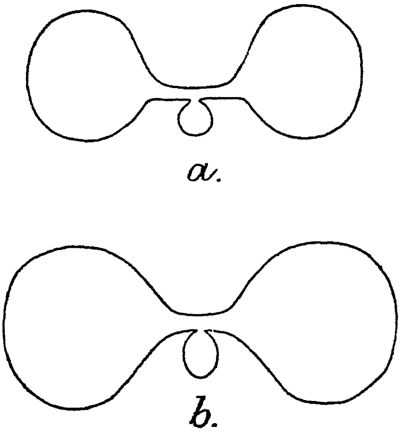


FIG. 1.—Normal type of air-bladder in *Nemachilus*.
(*a*) *N. manipurensis* Chaudhuri, ×10.
(*b*) *N. rupicola* (McClelland), ×10.

As a rule the air-bladder in these fishes is greatly reduced and is enclosed in two bony capsules. In a previous paper I (1922, p. 66) indicated how normal Cyprinoid bladder, such as that of *Labeo rohita*, becomes gradually modified into a bladder of the *Nemachilus* type and this modification becomes still further marked in highly specialised hill-stream fishes, such as the Homalopterid fish *Balitora*. I now want to direct your attention here to the reverse changes that have taken place in species of *Nemachilus* living in calm waters at high altitudes.

In the Inlé Basin, Southern Shan States, Burma, there are four endemic species of *Nemachilus* besides the widely distributed *N. botia*. The habitats of the four species are different and these differences are reflected in the structures of their air-bladders. Specimens of *N. shanensis* Hora were collected in a very fast current in a rocky stream and the species in every respect seems to be highly modified for this habitat. Its bladder is of the normal type. It may be noticed that in this bladder there is a long and narrow horizontal tube that connects the two lateral chambers of the anterior portion of the bladder and that the posterior portion is greatly reduced in size. In *N. rivulicola* Hora, which inhabitats clear, rocky streams of the Yawnghwe Valley and the He-Ho plain and several specimens of which were collected by me in a small stream flowing out of a spring near Fort Stedman, the air-bladder has somewhat deviated from the normal type. The two lateral chambers have become enlarged and the tube connecting the two is wider and shorter. The other two species—*N. brunneanus* Annandale and *N. brevis* Boulenger—live in sluggish waters and are commonly found in the Inlé Lake. The former is a slender species closely related to *N. rivulicola* Hora from which it is distinguished by its larger eyes and complete lepidosis. Both of these features, it may be remarked, are characteristic of sluggish water Cyprinoids. In *N. brunneanus* the two lateral chambers are greatly enlarged and are almost continuous; the connecting tube being represented by a

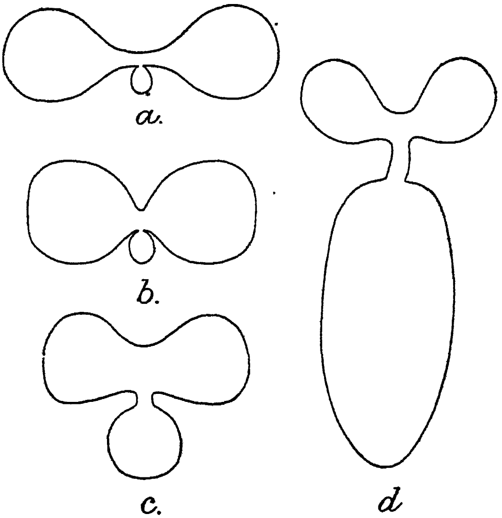


FIG. 2.—Four species of *Nemachilus* from the Inlé Basin, S. Shan States, Burma, showing the gradual evolution of the functional air-bladder.
(*a*) *N. shanensis* Hora, × 10.
(*b*) *N. rivulicola* Hora, × 10.
(*c*) *N. brunneanus* Annandale, × 10.
(*d*) *N. brevis* Boulenger, × 6⅔.

slight constriction only. The posterior chamber is also enlarged, but its walls are thick and fibrous. In *N. brevis* the posterior chamber is still further enlarged and its walls are thin and elastic. It occupies a considerable portion of the abdominal cavity and is connected with the anterior bilobed chamber by a well-marked tube. There can hardly be any doubt that this air-bladder of *N. brevis* is capable of performing hydrostatic functions as effectively as the normal Cyprinoid bladder.

So far as the structure of the air-bladder is concerned in the four species of *Nemachilus* referred to above we possess a highly instructive series showing the gradual modification of the structure induced by the direct effect of the environment, and it is also clear that the structural changes are of great utility for they bring about a direct correlation between the organism and its environment. The greatly reduced bladder of *N. shanensis*, a torrent-inhabiting form, is represented in *N. brevis*, a lake-inhabiting species, by a fully formed hydrostatic organ.

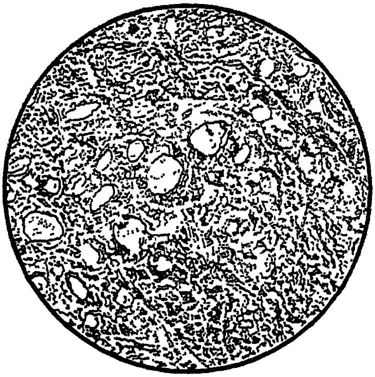


FIG. 3.—A portion of the wall of the bony capsules enclosing the lateral chambers of the anterior portion of the bladder of *Nemachilus brevis* Blgr. (from a photograph).

Correlated with the modifications of the bladder described above, there is a series of gradual changes undergone by the bony capsules. As the lateral chambers of the air-bladder increase in size the walls of the bony capsules become thin, and in species like *N. brevis* they are extremely brittle and perforated. Another change that is clearly noticeable even from the outside is that the walls of the bony capsules nearest to the skin on the sides remain incomplete so that the air-bladder comes in close contact with the skin. In these regions of contact the skin becomes thin and translucent. By these modifications the lateral chambers of the anterior portion of the bladder are brought in close contact with the surrounding water, and are enabled to perceive directly the varying hydrostatic pressures to which the fish is subjected in its up and downward movements in deep waters.

I do not want to discuss here the other structural modifications undergone by these fishes in response to changes in the habitat for I believe it is fully recognised now that any change in the character of an organism changes the organism as a whole.

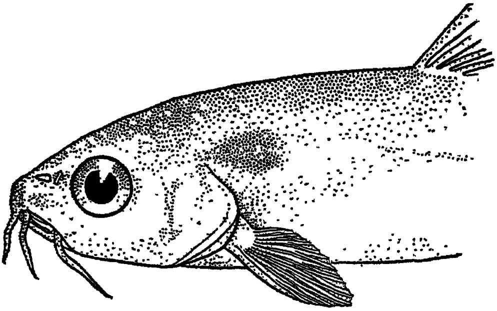


FIG. 4.—Lateral view of head and anterior portion of body of *Nemachilus brevis* Blgr., showing the deeply shaded area where the bladder comes in contact with the skin, × 3¾.

The Nemachili from the Inlé Basin are not unique in possessing the modifications described above for these fishes in other parts of the world, whenever occasion arose, adapted themselves to life in deep waters by a similar, if not identical set of modifications. *Nemachilus raoe* Hora lives in calm waters, for the only specimens of this species known so far were

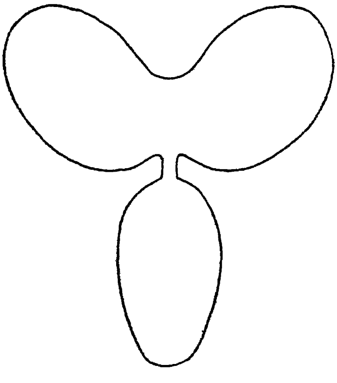


FIG. 5.—Air bladder of *Nemachilus raoe* Hora, × 15.

procured by my colleagues Dr. B. N. Chopra and Dr. H. S. Rao from a large tank full of weeds near the Inspection Bungalow at Mongyai in the Northern Shan States of Burma. In this species, the air-bladder is similar to that of *N. brevis* with this difference that the posterior chamber is not so extensive and the tube connecting the two chambers is not so long. Nemachili that inhabit the Kashmir Valley, show a gradual evolution of the hydrostatic bladder. *N. kashmirensis* Hora inhabits small streams in the valley and possesses an almost normal type of bladder. *N. marmoratus* (Heckel) lives in ponds and springs and in this species the two lateral chambers of the anterior portion of the bladder are well-developed; the posterior portion is also well-marked but its walls are very thick and fibrous. *N. vittatus* (Heckel) is widely distributed in

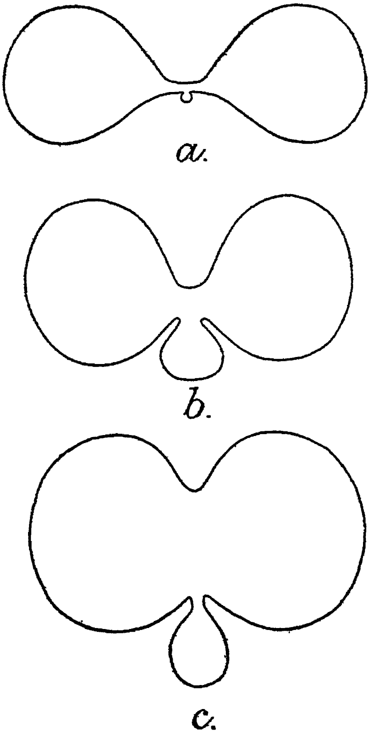


Fig. 6.—Three species of *Nemachilus* from the Kashmir Valley showing the gradual evolution of the functional air-bladder.
(*a*) *N. kashmirensis* Hora, × 11¼.
(*b*) *N. marmoratus* (Heckel), × 11¼.
(*c*) *N. vittatus* (Heckel), × 6.

the sluggish waters of the valley and is commonly found in the Wular Lake; the anterior portion of its bladder[1] has become still further enlarged and the posterior portion, though fibrous and probably inelastic has become of considerable size.

In the highlands of Central Asia there are found certain species of *Nemachilus* in which the air-bladder is essentially of the same type as that found in *N. brevis* with this difference that the two portions of the bladder are separated by a considerable distance and consequently the tube connecting the two is thin and long. This condition of the bladder appeared so remarkable to Kessler that he established the genus *Diplophysa*[2] on this character and described a number of species in this genus. During my recent visit to Europe I had an oppor-

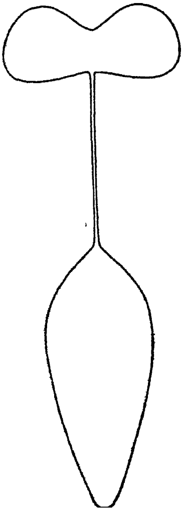


FIG. 7.—Air-bladder of *Nemachilus strauchii* (Kessler), ×2 (Diagrammatic).

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[1] In 1922 (*Rec. Ind. Mus.* XXIV, p. 67), I published a figure and a short description of the bladder of *Nemachilus vittatus* and pointed out the presence of a pneumatic duct. I have now dissected a large number of specimens and find that no such structure exists.

[2] The original description of the genus *Diplophysa* is as follows:—"Corpus valde elongatum, ad finem posteriorem conspicue compressum, alepidotum; oculi, plica palpebriformi, a rostri apice atque a rimis branchialibus aeque fere remoti; ossa infraocularia parva, sine spina mobilis; os cirris sex obsitum atque cinctum duobus labiis carnosis, quorum superius plus minusve denticulatum, inferius, bilobum, plus minusve papillosum: pseudobranchiae absunt; vesica natatoria in duas partes, anticam, involucro osseo bilobo praeditam, et posticam, elongatum, ventriculo superpositam, partita."

tunity of examining specimens of *D. strauchii* Kessler, the logo-type, and *D labiata* Kessler in the Zoologisches Museum der Universität, Berlin. In the absence of any material and of the original description of *Diplophysa* I had formed a wrong idea of the structure of the air-bladder of this genus and consequently in reviewing its systematic position in 1922 I attached undue importance to this structure. In view of the observations made above it seems hardly justifiable to recognise *Diplophysa* as a distinct genus from *Nemachilus* for all gradations exist between the typical bladder of *Nemachilus* and the "double bladder" of *Diplophysa.*

All the nine species of "*Diplophysa*" described by Kessler are known to inhabit deep rivers or lakes. *D. strauchii* and *D. labiatus* are from Eastern Turkestan; *D. intermedius, D. nasalis, D. costata,* and *D. dalaicus* are known from lake Dalai-nor, which is situated in the lake basin of Mongolia and *D. kungessana, D. papilloso-labiata,* and *D. microphthalmus* are found in the Tarim river-system which ultimately drains into Lake Lob-nor. I have shown elsewhere that the fauna of the high altitudes is in most cases derived from the neighbouring mountain streams and has become secondarily modified for life in sluggish waters. This reversion of habitat brings about a reversion in the evolution of the animal organisation, but in no case does the animal develop its truly primitive characters for the path of progression is different from that of regression.

A species of *Nemachilus* (=*Diplophysa*) showing remarkable modification of the air-bladder was described by me in 1922 from Eastern Tibet. Of this species—*N. stewarti* (Hora)—several young and half-grown specimens were collected by Capt. R. S. Kennedy and Capt. F. H. Stewart in a stream flowing into Rham-tso. The air-bladder of *N. stewarti* is as usual divided into two portions which are connected by a short and narrow tube[1], the anterior portion is bilobed and partially enclosed in bone and its two lateral chambers are connected by a short and narrow neck; the posterior portion, which lies free in the abdominal cavity, is divided into two chambers by a constriction thus assuming to a certain extent the form of a normal Cyprinoid bladder. The most remarkable point about this bladder is that it possesses a short pneumatic duct connecting the anterior end of the posterior portion of the bladder with the oesophagus. In this respect the air-bladder of *N. stewarti* has reverted to the primitive Cyprinoid condition

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"Ad genus Botia Gray proxime accedit, sed differt carente spina mobili in ossibus infraocularibus." Kessler, *Bull. Soc. Sci. Moscou,* XI, p. 57 (1874).

[1] In 1922, when I described this structure, I missed the connection between the two portions of the bladder, and, therefore, erroneously considered the two portions as distinct bladders.

so far as its function is concerned though structurally it is still very different.

I have yet to refer to an extremely remarkable species of *Nemachilus* described by me from the Northern Shan States, Burma. Of this species—*N. acuticephalus* Hora—I have examined only five specimens collected by Dr. J. Coggin Brown from the Hwe-gna-sang River in the Pazi Township of the Monglong Subdivision of Hsipaw State. Its rounded and tapering head, the small and compact fins, and the general facies suggest that the species is adapted to a burrowing mode of life.

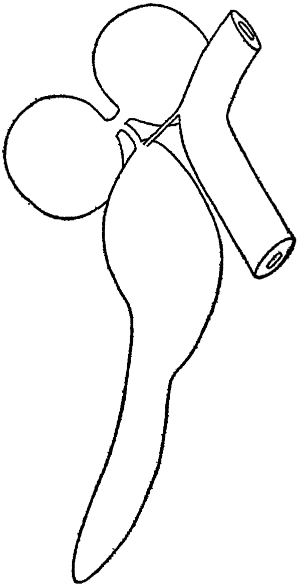

FIG. 8.—Air-bladder of *Nemachilus stewarti* (Hora), × 7½.

But this is a mere assumption for no observations are available regarding its precise habitat.[1] The bladder of *N. acuticephalus* is similar to that of the Central Asiatic species of *Nemachilus* referred to above; the anterior and the posterior portions of the bladder are connected by a long and narrow tube. Outwardly there is little evidence of such a modification of the bladder and the bony walls of the capsules are fairly compact and solid. If my surmise about the habitat of this species be found correct by later investigators, the modification of its bladder could then be accounted for in this way. From the nature of the bladder there seems no doubt that the immediate ancestors of *N. acuticephalus* were inhabitants of deep waters where the bladder served as a hydrostatic organ. On taking to a burrowing mode of life the bladder is becoming reduced again. If this explanation be found correct then we have here a striking illustration of the phenomenon of reversion in evolution on a grand scale. The normal Cyprinoid bladder first became reduced in swift currents and then in the calm and placid water of deep rivers and lakes at high altitudes it regained its functional activity by undergoing a set of structural modifications Later, on account of the burrowing habit of the species it has started to retrograde. It seems to me probable that environment is the supreme master of most of the changes in animal organisation and that organic evolution is a manifestation of the varied conditions under which life can exist.

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[1] It may be remarked here that the other species of fish obtained by Dr. J. Coggin Brown from the Hwe-gna-sang River belong to highly modified hill-stream genera.

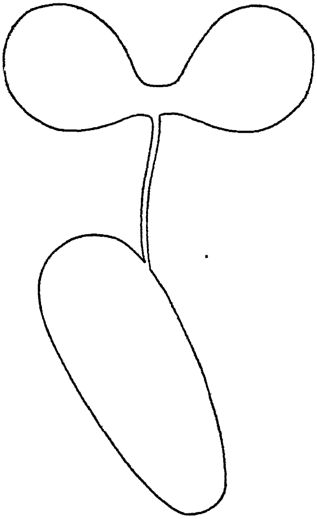

FIG. 9.—Air-bladder of *Nemachilus acuticephalus* Hora, × 15

It has been remarked by Bridge and Haddon that the assumption of a purely ground habit of life is the most important cause that has led to the degeneracy of the air-bladder in so many forms of fishes. I have also subscribed to this view. The observations recorded above give the fullest measure of support to this hypothesis, for it is clear that as soon as a fish gives up its ground habit of life, its air-bladder begins to revert and to function as a hydrostatic organ. It seems to me probable that for a similar reason the lungs of brook-inhabiting Amphibians are reduced. Noble's recent explanation that the "increased oxygen contents of mountain-stream water is one of the factors permitting lung reduction in Amphibia living in these waters" is true only to a very limited degree. In 1923, I made certain observations on the lungs of two tadpoles, *Rana afghana* and *Megalophrys parva*. Both are found living together in the small, torrential streams in the Khasi Hills, the former adhering to the exposed surfaces of rocks and stones in a swift current and the latter skulking under rocks or among roots of vegetation in the same place. There is no difference in temperature in the habitats of these two tadpoles and yet in *R. afghana* the lungs are small and non-functional for the entire period during which it lives in rapid waters and in the tadpoles of *M. parva* the lungs are represented by two thin-walled sacs which are distended by air-bubbles. These differences in the lung structure are correlated with the mode of life of these tadpoles. The tadpoles of *R. afghana* lead a ground habit of life and in them a pneumatic structure would have been distinctly harmful, whereas the tadpoles of *M. parva* use their lungs as hydrostatic organs when during periods of drought they are isolated in small pools and puddles.

Noble has given several instances to show that the lung reduction in the Amphibia is not confined only to torrent-inhabiting forms and has supported his contention by remarking that the air-bladder of fishes has been reduced or lost in other habitats besides the mountain brooks. This is perfectly true, but the fact should not be overlooked that wherever the reduction of the bladder has been observed it is known that those fishes lead a ground habit of life. For instance, in the mud-inhabiting Siluroids of India, such as *Clarias* and *Saccobranchus*, the air-bladder is greatly reduced and is enclosed in bony capsules. The habitat of these fishes is very different from that of the brook-inhabiting forms, yet the reduction of the air-bladder increases the specific gravity of both kinds of fish so that they can remain near the bottom in their respective habitats. I have shown elsewhere that animals living under different conditions may be called upon to respond in similar fashion to a common factor in their habitats, which would lead independently to "functional adaptation to similar ends" and thus result in convergence of characters. In the study of "adaptations" there are two things to be considered, the modifications in the characters of an organism and the factors that influence its life in an environment. When the study of both of these problems goes hand in hand, there is not the least doubt we shall have satisfactory data for the study of the method of organic evolution.

The study of the characters of organisms is greatly advanced but the study of environmental factors is still in its infancy.

I shall, therefore, state briefly what I mean by isolating and studying the factors in an environment. It is usually considered enough for a field collector[1] to sweep the bed of a small torrential stream with his bag-net and transfer his catch to a tube containing some alcohol and label the entire lot "from a clear, rapid-running stream with rocky bed and little vegetation". Such a label is obviously misleading for a brook consists of a series of rapids, falls, and pools, and generally flows over a rocky bed with tufts of mosses and weeds covering rocks and stones here and there. The fauna of the pools is different from that of the rapids and, again, the animals that live on rocks in a rapid are different from those that live in the moss. In October last I subjected to a thorough investigation a small rapid in the stream below the Dumpep Dak Bungalow in the Khasi Hills. The rapid was formed by a series of small falls so that the water in falling over them sparkled and foamed and appeared like a miniature silver cascade. At the base of the rapid there was a broad basin formed by a single slab of stone over which the water rushed with considerable speed. In the rapid itself certain portions of rock were covered with moss while others were quite bare. On the bare rock only nymphs of the mayfly genus *Baetis* were found while the moss harboured a fairly rich fauna. Nymphs of Plecoptera and Ephemeroptera, larvae of *Simulium*, Chironomidae, Trichoptera, and of *Elmis*, two kinds of beetles and two kinds of bugs were found in the moss. In the basin below the rapid the substratum could be divided into three distinct regions, namely, (i) bare rock, (ii) moss-covered rock, and (iii) rock covered with tufts of the weed *Eriocaulon miserum* Kern. It may be remarked that the current was not so swift in the basin as it was in the rapid. The bare rock in the basin was inhabited by the nymphs of *Baetis* and a few *Simulium* larvae. The moss in this region harboured a richer and more varied fauna than that found in moss in the rapid. The weed *Eriocaulon* provided better shelter and substratum for a foothold and, consequently, it contained the richest fauna in this habitat. Lepidopterous and Coleopterous larvae and Naucorid bugs were found among the roots of the plants; *Simulium* and Chironomid larvae were found on the exposed surfaces of leaves and stems while several kinds of nymphs of Ephemeroptera and Plecoptera, Rhyacophilid larvae of Trichoptera, Elmid beetles, and a few Planarians were found entangled among the leaves and stems of plants. Thus there are three different habitats into which the fauna of these weeds can be roughly divided and the animals of each habitat are differently modified. My collection from the habitats referred to above has not been worked out yet and, therefore, I cannot go into greater details about animal adaptations here, but I hope the broad outline of the classification of habitats that I have laid before you is sufficient to show what difference the nature of the substratum alone makes in the distribution of the fauna even when all other factors remain the same. The value of field observations is the greatest in the study of animal ecology, and I do not see how it can be possible to distinguish various "strata" in an environment by carrying out experiments, however detailed and elaborate, in a laboratory. I believe that the place of field observation in the study of evolution cannot be usurped. Experimental Zoology has its own rôle to play, and I do not underrate its value. In this country we have excellent opportunities in a field which is still so little explored. The late Dr. N. Annandale directed our attention to the vast opportunities open to us in the study of zoology from a biological point of view and Col. R. B. S. Sewell has impressed on us "the paramount importance to this country of the study of Ecology and Bionomics." He advised us to go out and study the animals in their own surroundings. A suggestion was made by Col. Sewell that one or two selected students from colleges and universities should accompany Zoological Survey parties so as to be able to study the fauna of this country in its natural surroundings under the guidance of a trained field worker. Unfortunately, no attention seems to have been paid to this generous gesture of the Director, Zoological Survey of India.

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[1] I do not in any way want to discourage amateur collectors because their collections are extremely valuable in increasing our knowledge of the general fauna of the country.

In making the above observations I do not for a moment underrate the importance of experimental physiology, embryology, morphology, taxonomy, or genetics; but I sincerely believe that the most effective method of elucidating the why and wherefore of Organic Evolution is to make direct observations on the organisms and their environments. The fact should not be lost sight of that the study of the latter is as important as the study of the animal itself.

LITERATURE.

Allen, E. J. ..	The Origin of Adaptations. *Nature* for June 1, pp. 841–843 (1929).
Annandale, N. ..	Evolution Convergent and Divergent (Presidential Address) *Proc. Eleventh Ind. Sci. Cong.*, pp. 1–26 (1924).
Bridge, T. W. and Haddon, A. C. ..	Contribution to the Anatomy of Fishes. II. The Air-bladder and Weberian Ossicles in the Siluroid Fishes. *Phil. Trans. Roy. Soc. London* (B) CLXXXIV, pp. 65–333 (1893).
Hora, S. L. ..	Notes on Fishes in the Indian Museum. III. On Fishes belonging to the family Cobitidae from high altitudes in Central Asia. *Rec. Ind. Mus.*, XXIV, pp. 63–83 (1922).

Hora, S. L. .. Observations on the Fauna of Certain Torrential Streams in the Khasi Hills. *Rec. Ind. Mus.*, XXV, pp. 579–600 (1923).

Hora, S. L. .. Notes on Fishes in the Indian Museum. XVII. Loaches of the genus *Nemachilus* from Burma. *Rec. Ind. Mus.*, XXXI, pp. 311–334, pls. XIV, XV (1929).

Huxley, J. S. .. Mendelism and Evolution. *Nature* for April 19, p. 569 (1924).

Kerr, J. G. .. *Evolution* (London: 1926).

Noble, G. K. .. The Adaptive Modifications of the Arborial Tadpoles of *Hoplophryne* and the Torrent Tadpoles of *Staurois*. *Bull. Amer. Mus. Nat. Hist.*, LVIII, pp. 291–334 (1929).

Parker, T. J. and Haswell, W. A. .. *A Text-book of Zoology* II, p. 668 (London: 1910).

Sewell, R. B. S. .. The Study of Zoology in India in the Future. *Proc. Fourteenth Ind. Sci. Cong.*, pp. 177–187 (1927).

Watson, D. M. S. .. Adaptation. *Nature* for August 10, pp. 231–234 (1929).

Section of Zoology.

Abstracts.

1. Some Reflections on Zoological Research in India.

BAINI PRASHAD, Calcutta.

In this paper, the author deals with such general questions as the selection of subjects for research, looking up of literature, and the preparation of papers on the results of investigations. The difficulties in the way of taxonomic research are dealt with in detail and suggestions are made for the likely sources where relevant literature in reference to the various lines of research should be looked for. The question of the preparation of manuscript and general arrangement of the subject matter are also dealt with in some detail.

2. Synopsis of the Genera and Classification of Haplocyte Gregarines.

B. L. BHATIA, Hoshiarpore.

Lankester's division of the order Eugregarinida into Septata and Haplocyta is preferred. The latter (Acephalina or Monocystidea) included according to Labbé (1899) 10 genera and 10 uncertain genera. The number of genera now included in the sub-order is 35, but they are not well arranged in families. The classifications of the sub-order proposed by Dogiel (1909) and Poche (1913) have not found favour with later writers. In this paper, a synopsis of all the genera is given and an attempt made at arranging the genera into families, using all the characters which are employed in the classification of Septata.

The sub-order is divided into two tribes, *viz.*, Homopolaridea and Heteropolaridea. The former comprise the families Monocystidæ, Rhynchocystidæ, Stomatophoridæ, Zygocystidæ, Aikinetocystidæ, Syncystidæ, Diplocystidæ, and Schaudinnellidæ, and the latter comprise the families Lecudinidæ, Urosporidæ, Ganymedidæ, and Allantocystidæ.

3. *Cercaria allahabadii*, n. sp.

R. C. CHATTERJEE, Allahabad.

(Communicated by Dr. H. R. Mehra.)

During the winter months at Allahabad the common Indian Snail *Indoplanorbis exustus* (Deshayes) is heavily infected with some forked-tailed larval trematodes that resemble closely Cercariæ Indicæ XXII Sewell. The points of difference are sufficiently important to distinguish them as a new species.

The cercaria is larger than Cercariæ Indicæ XXII Sewell. Length of the body, the main stem, and the ramus are equal each measuring ·2 mm. Width of the main stem is uniform throughout and measures ·027 mm. The greatest width of the body is ·04 mm (in the region just anterior to the acetabulum). Width of the body at the point of junction with the tail is equal to that of the main stem.

The "*penetration gland cells*" four in number lie anterior to the ventral sucker as in Cercariæ Indicæ XXII Sewell, but their arrangement is somewhat different. The first two cells instead of being situated at the same level lie one behind the other, whereas the second pair occupies the same level. The narrow ducts pass ventrolaterally to the penetrating organ to open at its anterior extremity. The penetrating organ in the retracted condition takes the form of a sucker. The pharynx appears as a bulbular enlargement of the œsophagus.

The *œsophagus* bifurcates into two narrow cæca, each of which ends in a saccular tripartite dilatation called " refractile bodies " by Sewell.

4. Systematic Discussion and Classification of the Family Lepodermatidæ Odhner.

H. R. MEHRA, Allahabad.

Nomenclature of the family is discussed. The name Lepodermatidæ is to be preferred to Plagiorchiidæ Lühe. Baer has recently separated a number of genera from the Lepodermatidæ under a new family Reniferidæ. This is not correct. The author agrees with Poche and maintains that the presence of side branches from the excretory bladder is not a character of family rank.

Relationships of the genera is discussed. The genera *Haplomera Haplometroides* and *Tremiorchis* are derived from *Lepoderma* and should be included with *Opisthoglyphe, Astiotrema,* and *Glypthelmis* in the subfamily Lepodermatinæ Looss. *Saphedra, Pneumonœces,* and *Phenumobites,* which are derived from *Haplometra* should constitute the sub-family Saphedratinæ Baer. The Brachycælinæ Looss containing the genera *Brachycœlium, Margeana,* and aberrant genus *Leptaphallus* is probably derived from *Tremiorchis*. The genus *Styphlodora* is derived from *Lepoderma* along another line. It is closely related to *Styphlotrema* and *Pachypsolus* and should be included with them in Styphlotreminæ Baer which is closely related to the Reniferinæ Prat *e.p.* Baer.

The sub-family Cæmatocarpinæ Baer should drop and the genera included in it should be assigned to the Reniferinæ and Styphlotreminæ. Enodiotreminæ Baer is an aberrant sub-family related to them. A new sub-family Opisthogoniminœ is created for the genus *Opisthogonimus*.

The Prosthogoniminæ Lühe should be included in this family. Ommatobrephidæ Poche is accepted for the genus *Ommatobrephus*.

5. On a new Species of *Lepoderma* (Looss). *Lepoderma himalayii*, n. sp.

E. L. JORDAN, Allahabad.

(Communicated by Dr. H. R. Mehra.)

This is the first species of *Lepoderma* (Looss) found in India. It was obtained by Dr. Mehra from the small intestine of the common toad of Kashmir. The body is oval and elongated with an average length of 2·2 mm. and an average breadth of 0·67 mm. The oral sucker is larger than the ventral sucker, and the latter lies in the anterior third of the body. A well developed œsophagus is present. The cirrus is very long, cylindrical, and slightly curved somewhat in a C-shaped manner. Prominent seminal vesicle and pars-prostatica are present. Genital opening lies slightly to the left immediately in front of ventral sucker.

The species resembles much *Plagiorchis mentulatus* (Rud.) in size and topography of organs. It differs, however, in (1) the shape and arrangement of vitellaria and uterus in the hinder portion of the body, (2) difference in size of the testes, (3) presence of an œsophagus, (4) host.

6. Studies on the life-history of an Echinostome.

R. C. CHATTERJEE, Allahabad.

(Communicated by Dr. H. R. Mehra.)

During August, September, and October, *Indoplanorbis exustus* near Allahabad is found to be heavily infected with the Cercarial and metacercarial stages of an Echinostome. The Cercariæ closely resemble *Cercaria agilis* on one hand and members of the Echinata group of the Echinostome Cercariæ Sewell on the other.

The chief points of difference from the Agilis cercariæ are the presence of a digestive tract with some associated gland cells, a row of thin collar spines, and a small number of flame cells. The flame cells have not been hitherto known in Agilis Cercariæ.

The body is covered with many cystogenous cells resembling those of the Agilis group. The excretory granules are also of the same pattern. A mass of genital cells (probably ovary) is situated behind the accetabulum.

Innumerable cysts of this cercaria are found closely packed in the mantle of the host. The encystment takes place long after the free stage. In the encysted stage a circular row of prominent collar spines around the oral sucker is easily recognisable.

✓ 7. On a new species of *Caryophyllæus* O. F. Müller from Kashmir with remarks on *Lytocestus indicus* (Moghe) 1925.

H. R. MEHRA, Allahabad.

The Family Caryophyllæidæ is hitherto represented in India by only one species *Lytocestus indicus* (*Caryophyllæus indicus* Moghe 1925). The author obtained in May 1929 a large number of specimens of a new species of the genus *Caryophyllæus* from the intestine of *Schizothorax micropogon* Heckel, the common fish available, near Srinagar.

Length 30–60 mm.; usually it varies between 40–50 mm. Maximum breadth in region of the male genital opening 1-2 mm. A more or less annular patch of light yellow colour usually separates head from the body. Body oval in transverse section. Head always broader than body in a more or less flattened specimen; longitudinal grooves on head absent. Genital apertures in last eighth to tenth of body length. Musculature typical of the genus. The vitellaria are cortical situated outside the thin epimedullary layer of longitudinal muscle fibres and arranged in a more or less annular manner around the testis. A few vitellarian follicles also surround the ovary. Post ovarian vitellaria present occupying a medullary position. Vas deferens strongly coiled. The ovary is entirely in the medulla. Uterine glands well developed. The vagina is nearly a straight tube. Uterus and vagina are united terminally to form a small tube which opens to the exterior at the female pore. The uterus is much convolute and does not extend in front of the female pore. Number of main excretory tubes behind and in the region of the ovary 10–13. Eggs measure 45-53μ in length and 30–33μ in breadth.

Systematic position of *C. kashmirenses*, n. sp. is discussed. The species apparently connects the two genera *Caryophyllæus* and *Lytocestus*. *Lytocestus indicus* (Moghe) belongs to the genus *Lytocestus* and not *Caryophyllæus*. A large number of specimens of this parasite were obtained from *Clarias magur*, near Mainpuri (U.P.). A brief description of its anatomy is given.

8. Indian Representatives of the genus *Avitellina* (Cestoda).

G. D. BHALERAO, Nagpur.

The author has dealt in this paper with three species of *Avitellina* found in India: *A. lahorea*, *A. Centripunctata* and *A. sudanea*. In the case of *A. lahorea*, Woodland's description is very largely supplemented and criticism is offered with regard to the adoption of the depth of the outer column of testes as a factor in separating one species of *Avitellina* from the other. Woodland's observations with regard to the application of Gough's rule to the relative positions of cirrus-sac and vulva in vertical plane in the case of *A. lahorea* is contradicted. Additional information is given with regard to the anatomy of the other two species.

9. On the Occurrence of Young *Polygordius* and *Polygordius* larvæ in townet water in Madras.

R GOPALA AIYAR, Madras.

Several post-larval *Polygordius* probably allied to *P. lacteus* were obtained in the month of September. Along with these, early stages of undoubted larvæ of *Polygordius* were also collected. These were kept alive for a few days and the characters of the larvæ as they metamorphosed were noted. The larvæ are provided with an "Amnion" as in *P. lacteus*. The amnion shrinks gradually as the larva grows and finally tears along one side and is cast off and the post-larval stage is assumed.

10. A criticism of Polychaete Taxonomy, with reference to the family Eunicidæ.

NAJMUD-DIN AZIZ, Lahore.

(Communicated by Dr. Vishwa Nath.)

Kinberg (1857) based the genera of Eunicidæ on the form of the cephalic lobe, presence or absence of tentacular cirri as well as the size, shape, and arrangement of the branchiæ. Quatrefages (1865) relied on the presence or absence of branchiæ as the sole criterion for distinguishing genera. Ehlers (1868–70) regarded the structure of the interposing piece of the upper jaw as of generic value. Claparède (1870) based his classification on the shape of the entire jaw. Recently Fauvel (1923) held that bristles, prostomium, tentacles, and branchiæ have a collective value in the discrimination of genera. The author has discussed the above views in his study of the Eunicidæ of Karachi.

11. Preliminary experiments and observations on the so-called "alimentary glands" of the earthworm *Eutyphoeus*.

K. N. BAHL, *and* M. B. LAL, Lucknow.

Eutyphoeus is a surface feeding earthworm unlike *Pheretima* which is a burrower. The castings of the two worms are very different. Darwin was apparently misinformed about these castings—his diagram of the castings of *Perichaeta* really represents the castings of *Eutyphoeus*.

Beddard was the first person to record the presence of "alimentary glands" in *Eutyphoeus* which he regarded as being of the nature of "calciferous glands". The following new observations on these glands may be recorded :—

(1) that they are situated not on the œsophagus but very much further back—a little behind the middle of the body,

(2) that they occur in connection with the typhlosole, only on the dorsal side of the body,

(3) that they occupy the last five segments of the typhlosolar region,

(4) that they open into the gut by several small or large openings all along their length,

(5) that they have a special blood-supply.

Two experiments were made to determine if these glands had a digestive (peptic) function. In (1) glands were taken out of 153 worms (weight of glands=2·918 gms.) and their extracts were kept at different temperatures for 24 hours with a control tube which was boiled. Titration with formol and soda revealed the presence of amino-acids. The best results were obtained at 30° C. In (2) glands (80 worms with weight of glands= ·9 gms.) were similarly kept at 30° C with control for 36 hours with the result that a much larger quantity of amino-acids was formed.

12. Note on a new sea-urchin of the genus *Chaetodiadema.*

D. W. DEVANESEN, Madras.

Chaetodiadema sundararaji, sp. nov.

In each inter-ambulacrum the primary tubercles are arranged in 8-10 vertical rows parallel with its mid-line. The bare inter-ambulacral areas in the abactinal region is markedly reduced, the first primary tubercle of the outermost row commencing on the sixth or the seventh plate. Each inter-ambulacral section of the granular area consists of but five large inter-ambulacral plates with an irregular outline. They are simple but large each carrying only a single pair of pores. The vertical diameter of the test is equal to the diameter of the apical field. The diameter of the actinostome is about one-fifth of the long diameter of the test. The triradiate spicules characteristic of the Diadematidæ are found in the buccal tube-feet as well as in the tube-feet of the test. A diligent and prolonged search for pedicellariae proved fruitless. The sphaeridia occur, strange as it may seem, both in the ambulacral and inter-ambulacral regions, hang down freely and are conspicuous structures which cannot be missed.

13. The Style-bearing Stomachs of some more Gastropods.

R. V. SESHAIYA, Tirupati.

1. A crystalline style and a style sac are found in *Potamides (Tympanotonos) cingulatus* (Gmelin), belonging to the family Cerithiidæ in which a style has not been recorded till now. 2. The style sac is of the type found in *Paludomus* and *Melanoides,* with a longitudinal groove on the pyloric side and a short slit like pyloric connection extending for a distance of about 0·6 mm. 3. The style sac of *Turritella* is of the same type as that of *Mysorella* and is not independent of the pylorus, as described by some authors. The style sac of *Bithynia* also has been examined and found to resemble that of *Mysorella.*

14. A note on the anatomy of *Amnicola* (*Alocinma*) *travoncorica* (Benson).

R. V. SESHAIYA, Tirupati.

The anatomy of *Amnicola* (*Alocinma*) bears a close resemblance to that of *Mysorella.* The differences are noted with regard to the gill lamellæ, the shape of the osphradium, the radula, and the female reproductive system. A comparison of the radula and male reproductive system of *Amnicola* is also made with those of *Bithynia.*

15. On two new species of the genus *Peronina* (Oncidiidæ) with notes on the genus.

B. PRASHAD *and* J. L. BHADURI, Calcutta.

While working out the collection of the family Oncidiidæ in the Indian Museum the authors have come across two new species of the hitherto monotypic genus *Peronina* Plate. The two new species are both from estuarine areas, the first from Vizagapatam Harbour and the second from an estuarine stream, Chingri Khal, near Calcutta. The exact *provenance* of the type species—*Peronina alta* Plate—is not definitely known, though Plate for unknown reasons considered it to have been probably collected at Madras. The authors give short descriptions of the two new species and discuss the position of the genus in the family.

16. Diagrams illustrating the External Morphology of the Arthropoda.

F. H. GRAVELY, Madras.

These diagrams have been prepared with the aid of various text-books, papers, and specimens. They are designed to show the form and arrangement of the different parts of the body and of the appendages which they bear in typical examples of the different Classes of the Phylum. The Crustacea are represented by *Apus, Calanus, and Panulirus;* the Arachnida by *Limulus, Palamnaeus, and Nymphon;* the Onychophora by *Peripatus;* the Myriapoda by *Scolopendra* and *Julus*, and the Insecta by *Campodea, Periplaneta,* and *Cimex.*

17. Record of a second '*Aeolothrips*' from India—(Thysanoptera).

T. V. RAMAKRISHNA AYYAR, Coimbatore.

A second species of the important genus *Aelothrips* is recorded from India. It was collected at the Koilpati farm (Southernmost extremity of India). On the basis of this discovery some comments on the distribution of the order Thysanoptera are made.

18. The Bionomics of Thysanoptera. *1. Nature and Extent of the damage done by Tubuliferous thrips (a) under maximum conditions of Drought.*

D. S. CHOWDHURY, Cawnpore.

The work was organised to study the nature and extent of the damage caused by Tubuliferous thrips on *Eugenia jambolana* Lamk., garden variety. The range of temperature was a mean maximum of 109°F. and a mean minimum of 84°F. both 3 degrees above the mean normals. The average relative humidity was 33% as against the average of the normal relative humidity which was 49%.

These conditions appeared to be unsuitable for thrips. The extent and intensity of infestation was low and the damage as evidenced in early shedding was only 3%.

The extent of deformity is determined by the extent of infection in general, whereas the extent of shedding follows more closely the extent of heavy infection and the magnitude of the numerical intensity factor.

The extent of damage, infection, heavy infection, and the magnitude of the numerical intensity factor all *vary directly* with the relative humidity.

19. On two undescribed forms of *Oligotoma* in the Indian Museum collection.

S. Mukerji, Calcutta.

Oligotoma minuta n.sp. Four specimens all males were collected by Dr. F. H. Gravely and Mr. C. Paiva from Calcutta and its suburb (Alipur) in the years 1911, 1914, 1915, and 1916. Besides the peculiarities of the asymmetrical 10th tergite, the species is remarkable in being the smallest among the Embiids so far recorded from India. Female is unknown. Total length of the male is 4.25 mm., while the fore and hind-wings measure respectively 3 mm., and 2.5 mm.

Oligotoma ceylonica subsp. *variegata,* nov. The author is in possession of 4 specimens. all males, of which two are apparently damaged, collected from Barkuda Island, Chilka Lake, Ganjam District, Madras, in the years 1922–23 and also from Peradiniya, Ceylon during the year 1910. The author describes in detail the variable features in the specimens collected from different localities. In its external genetalia, the new sub-species resembles to a certain extent *Oligotoma japonica* Oka., (1926). In its external genetalia and some other features the sub-species also resembles to a certain extent *Oligotoma ceylonica* Enderl., and a comparative account of the external genetalia of the two forms has been appended. The author is of opinion that the position of *Oligotoma japonica* Oka, as a district species is untenable.

20. Notes on Anopleura (Blood-sucking lice) of Lahore.

Madan Lal Bhatia, Lahore.

(Communicated by Dr. Vishwa Nath.)

The author has collected five species from cattle. Each species seems to have a specific host. Previous authors have worked mainly on *Pediculus capitis* and *P. vestimenti,* the head and body lice of man. The author is at present engaged in investigating the life history of *Haematopinus tuberculatus* and *Linognathus stenopsis.* In these forms the metamorphosis is incomplete while the period of growth is accompanied by several moults.

21. Cross veins in the filamentous hind wings of *Croce filipennis* Westw., ♂ apparently of the nature of secondary sexual character.

S. Mukerji, Calcutta.

The Hemopterids are peculiar in that the adult forms are in most cases sexual ones. With this modification the mouth parts become mostly non-functional although the representatives of different parts are not lacking. The nuptial flight of the sexual forms is a series of up and down movements and this peculiar movement of the insect is apparently facilitated by the rapidly vibrating ribbon-like posterior wings. A microscopic examination of the hind wings of both the sexes reveals a coalesced longitudinal vein. The author in the case of hind-wings of the males found a series of parallel cross vein-like structures running to the anterior and posterior margins of the costal vein. Under high power these cross-veins reveal a spiral structure. In the present state of our knowledge of the group apparently nothing is known about the existence or function of these structures in the thread-like hind-wings. The author thinks that these structures are probably of the nature of a secondary sexual character.

22. Effect of temperature and humidity on the delivery of young and development of the embryo in lac insect (*Laecifer lacca*) and its progeny.

P. S. Negi, S. N. Gupta, *and* M. P. Misra, Namkum.

The paper is in continuation of the one read at the last Science Congress at Madras. (1) Humidity plays no part in egg laying. (2) The temperature on the other hand is an important factor both as regards egg laying and embryonic development. (3) If in any season and especially in winter, swarming which is naturally due, is likely to be checked by climatic conditions, it can be induced by keeping the brood in a room at a temperature of 24°–28°C or by keeping it for 3–4 days at a temperature of 5–6°C below atmospheric temperature and then exposing it to the latter. (4) The progeny of the brood lac kept at a lower temperature than atmospheric does not suffer either in the sex ratio or in the yield.

23. Proportion of male larvæ to female larvæ for each day of emergence and parthenogenesis in the lac insect (*Laecifer lacca*).

P. S. Negi, M. P. Misra, *and* S. N. Gupta, Namkum.

Studies on the proportion of male larvæ to female larvæ for each day of emergence show that the emergence of larvæ from the test of the mother is of mixed character and it is only a matter of chance that on a certain day the batch of larvæ which emerges out consists of more males or more females.

The lac insect can reproduce parthenogenetically for at least two generations. The parthenogenetically reproduced third generation develops normally till the pupal stage, but the growth of the female, if fertilisation be prevented, is retarded and it produces less resin and fails to reproduce.

24. The respiratory System of the larva of *Cybister.*

Durgadas Mukerji, Calcutta.

There exists a difference of opinion as to the nature of spiracles in the larva of *Cybister,* but the histological details of spiracles are lacking. Portier (1911–12) states that all the spiracles except the last abdominal pair are closed and non-functional in the larva. The author, in the present paper, describes the tracheal system, the structure, and function of the spiracles and the habit of the *Cybister* larva not hitherto investigated in India. He finds that the spiracles situated at the anterior region of the body are open like the last abdominal to the exterior throughout the larval life and that they are of use in respiration specially when the larva comes to live on land.

25. On the significance of the structures of the terminal segments as affording reliable generic and specific characters in the Psychodid larvæ.

S. Mukerji, Calcutta.

Specific variations are prominently confined to the two terminal segments in the case of the genus *Phlebotomus* and only to the last segment in the case of the genus *Psychoda.* In the semi-aquatic larvæ of *Psychoda,* the terminal segment becomes modified into a tubular structure with the spiracular openings arranged at its tip; specific variation was also observed in the case of sclerites surrounding the anal pore. In the larvæ of *Phlebotomus* which are remarkably terrestrial the posterior pair of spiracles becomes shifted to the penultimate segment.

The structural modifications of the terminal segments of larvæ of the following species have been studied:—

Psychoda bengalensis Brun., *Psychoda plumosa*, sp. nov., *Phlebotomus argentipes* Ann. & Brun., *Phlebotomus papatasii* Scop., and *Phlebotomus minutus* Rond.

26. Notes on the Bionomics and Anatomy of *Corizoneura longirostris* Hardwicke.

S. K. Sen, Muktesar.

At Muktesar (Kumaon; 7,500 ft.), the seasonal prevalence of *C. longirostris* extends from the end of July to the beginning of September, and during this period they have been frequently observed to feed upon flowers of *Roscoea purpurea*, Smith (Family Scitamineæ), these flowers making their appearance and disappearing about the same time as the flies themselves.

It appears that the mouth-parts of the female are adapted for sucking mammalian blood. In the course of the dissections large quantities of blood were detected in the alimentary tracts of at least two specimens, whilst in one instance a fly was actually observed to suck blood from a pony.

About 150 eggs, apparently in an advanced state of maturity, were dissected out in one instance. Attempts to induce the flies to oviposit in captivity were unsuccessful.

The reproductive tracts of both male and female *C. longirostris* are briefly described.

27. Cephalic sensory organs of a full grown mining maggot *Agromyza* (*Melanagromyza*) *pulicaria* Mg.

S. Mukerji, Calcutta.

28. Life-History of the moth *Paralebeda plagifera*.

N. K. Ganguli, Lahore.

(Communicated by Dr. Vishwa Nath.)

The life-history of this species of moth has not, to my knowledge, been worked out before. During the course of one year the author has made observations on all the stages from the egg up to the imago. The extraordinary feature is that the larval period sets in after summer and lasts through the winter, (September to April), while the pupal period is much shorter lasting only one month (April to May). The imago emerges early in summer.

29. Web-formation in some Orb-weaving Spiders.

Sukh Dyal, Lahore.

(Communicated by Dr. Vishwa Nath.)

The spider lays the first bridge line by ejecting a thread which on coming in contact with a suitable object such as a branch of a tree becomes permanently attached to it. On this bridge line a variable number of foundation lines are laid down. The spider then forms an outer circular line and radial lines followed by spiral lines. In the cases studied by the author the greater part of the web is occupied by the spiral space. The foundation space is not extensive and the central space does not possess any free zone with the result that the notched zone is hardly distinguishable from the spiral space. The hub proper is meshed.

Certain species of *Araneus* form telegraph line and retreat. In the only species of *Hentzia* met with so far, the orbweb is horizontal and it is covered above and below by retitelarian lines. In most species of *Cyclosa*, the spider lays the debris of its victims on one diameter of the vertical orb leaving an empty space in the centre to accommodate itself. In two species of *Uloborus* the debris of victims are laid on only one radius of the orb.

30. The Caudal Skeleton of *Clupea.*

S. G. MANAVALA RAMANUJAM, Madras.

In this paper, the adult structure of the caudal skeleton is explained by reference to its development and the homology of the component parts stated.

The penultimate centrum of the adult is shown to be a double centrum whose ventralia are represented by the hypurals 7 and 6. The 6th hypural, however, gets detached, leaving its anterior continuation between the limbs of the anterior, *i.e.*, the 7th hypural. (It is unfortunate that hypurals are conventionally numbered from the posterior end). Beyond this penultimate centrum three other vertebral segments could be recognised in earlier stages, the last two of which atrophy, only persisting in later stages, as a small process on the top of the first which is also reduced and forms the so-called last centrum carrying the fifth hypural fused with it. Hypurals 4 and 3 represent the ventralia of the two aborted vertebrae. Hypurals 2 and 1 are each developed without a distinct centrum, though intermedial ossifications occur in their place.

The penultimate centrum carries also two pairs of dorsalia. Its posterior pair, however, fuses with the dorsalia of the three succeeding vertebral segments to form a continuous plate, called the uroneural, on each side of the spinal cord and notochord in their upturned region. The dorsal part of the uroneural enclosing the attenuated spinal cord is distinguished as the triangular plate. The posterior end of the basal (ventral) part of the uroneural, *i.e.*, beyond the triangular plate represents the neuralia of the undeveloped centra whose ventralia are represented by hypurals 2 and 1. The intermedial ossifications representing the undeveloped centra fuse to form 'the ensheathing bone' which is articulated to the small remnant of the two last aborted vertebral rings.

31. On the Osseous System of Mastacembelidæ.

EKENDRANATH GHOSH, Calcutta.

Skull elongated and tapering. Roof smooth, with a sinuous interfrontal suture. Supraoccipital extending in front just between the posterior ends of the two frontals and separating the parietal from each other. Opisthotic absent. Basisphenoid very small. Orbitosphenoid very rudimentary, sometimes fused with prootic. Suborbitals minute and cartilaginous. Pre-orbital large and on the outer side of the large nasal. Platelike mesethmoid greatly elongated and extending between the frontal bones to half their lengths. Ectethmoid ring-like and short. Nasal bones not meeting in the middle line. Two articular processes on the hyomandibular for the otic bones. Ectopterygoid movably articulating with ectethmoid. Palatine not meeting the ectopterygoid but immovably articulating with ectethmoid, parasphenoid, and vomer. Maxilla displaced from the border of mouth. Hyoid and branchial bones percoid in character. Centrum of first vertebra convex in front. First four precaudal vertebræ differing from the rest in having flattened neural spines, epipleurals from parapophyses, and in having no ventrolateral processes connected with parapophyses. Tail is gephyrocercal. No supra-and post-temporal bones. Narrow supracleithrum attached by ligaments to parapophysis from the second to the fourth vertebræ according to different species. Hypocoracoid perforated. The skeletal characters show that the group Opisthomi is a specialised offshoot of the Percomorphi and does not seem to be related to any particular group.

32. Observations on a new mode of Aerial respiration in an Estuarine Gobiid.

B. K. Das, Calcutta.

This fish occasionally comes to the surface (varying at an interval of 1 to 4 minutes, or sometimes even more quickly) with a sudden dart so that its head breaks the surface film almost abruptly, and while descending downwards it makes a second upward movement, opens its mouth and takes a gulp of air, which is being at once stored inside the opercular chamber. The branchiostegal membrane firmly closes over the gill-opening, and thus the opercular chamber is bulged out on either side of the head in the form of a small bladder. In this condition the fish hangs down almost vertically with the greater portion of its head sticking out of water, probably due to the buoyancy created by the two inflated opercular cavities. After quietly lying afloat for about 2 to 4 minutes the fish gives out all air by opening its mouth, and off it briskly wriggles back inside water until it reaches the bottom of the aquarium. Branchial respiration is normally slow, though gills are developed over the four gill arches. A gas-bladder is present.

If there are certain weeds in the aquarium the fish usually hangs on to them with the help of its widely spread out pectoral fins. Resting over the weeds it has been observed to take repeated gulps of air, and is thereby able to sustain itself much longer above the surface of water. While it floats with the opercular chambers bulged out it closely resembles *Amphipnous cuchia,* but, unlike the other air-breathers, there is no development of any special air-breathing organ in this fish,... in a simple way opercular chambers have adapted themselves to accommodate air, and subserve aerial respiration.

33. Early Stages in the development of *Cirrhina mrigala.*

M. Hamid Khan, Lahore.

Cirrhina mrigala has successfully bred in the Departmental tanks at Chhanawan during the months of July when the tanks are flooded by the rain water from the fields. Actual spawning was observed to take place in early hours, the fish playing together with their caudal portions in contact crosswise: eggs and milt being shed at the same time. A ripe female was stripped and milt mixed with its eggs. Eggs got swollen when submerged in water. The different stages in its development were observed under the microscope. Segmentation proceeds rapidly and the embryo is differentiated within the vitelline membrane within 12 hours with colourless eyes, a pair of otoliths, 30 somites, and an elongated tail. Hatching takes 20 to 24 hours. Newly hatched embryo shows simple tubular heart with anterior and posterior veins, caudal vessels, simple yolk capillaries, and small bud like pectoral fins.

Second day after hatching shows pigment in the eyes and external gills. Mouth opens for respiration. Caudal capillaries and air sac appear on the third day. Gut opens on the fourth day, and caudal capillaries have also multiplied. Yolk sac is totally absorbed and caudal rays have also appeared. Fifth day shows multiplication of caudal rays and formation of basal cartilages. Dorsal fin appears on the 7th day, and anal fin on the 12th, and pelvic fins on the 14th. Caudal fin separates off on the 16th day. Embryo becomes opaque on account of the presence of yellow pigment and round black pigment cell.

34. Remarks on the exhibition of grape-bunch-like egg-masses of *Arius thalassinus.*

B. K. DAS, Calcutta.

The author proposes to demonstrate and describe the condition of the ovaries, the variations in number, and size of eggs in each ovary and the mode of breeding in the fish.

35. A preliminary resume of four years' observations regarding the fluctuations of some biological, Physical, and other factors possibly influencing the migrations of the Sardine (*Clupea longiceps*) and the Mackerel (*Scomber microlepidotus*).

S. T. MOSES, Madras.

Introduction. The Sardine. Statistics of its occurrence off Calicut. Fluctuations in the 4 years in habits and life-history. The Mackerel. Statistics of its occurrence. Fluctuations in habits and life-history. Plankton. Phytoplankton and its fluctuations. Flagellates and Infusorians and their fluctuations. Copepods, etc., and their fluctuations. Fluctuations of other organisms in the Plankton. Meteorological and other conditions. Fluctuations in Rainfall. The Winds. The Current. The Surf. The temperature of the sea-water. Specific Gravity of the sea-water. Conclusion.

36. Methods of Fishing in the Punjab.

M. HAMID KHAN, Lahore.

I. *Methods of fishing before the Fisheries Regulations came into force were innumerable and seemed to have been devised with the express purpose of allowing nothing however small to escape. Some of the most harmful methods are :—*

(1) Poisoning. In May and June when the streams are low in the hilly tracts, fishes are ruthlessly poisoned and wanton destruction of entire animal life is incalculable. (2) Dynamiting. (3) Fixed Engines including *Urli*, a conical shaped contrivance of basket work. (4) Diversion of water for killing fish, including *Bah* and *Chipli*. (5) Erection of dams, weirs, traps, etc., for killing fish and fry, *e.g.*, *Trop, Patal, Dhingri* or *Adhani, Dhap, Batarru*, and *Dahnu*. (6) Continuous netting with small meshed nets, *e.g.*, *Dou* and *Sambi*.

II. *Methods permitted under the Punjab Fisheries Act II of 1914 are :—*

(1) Drag net used in conjunction with stake net (*i.e.*, *Bhiga, Kadh* Kurga, Chhatta, and Mahjal), with a minimum mesh of 1¼ inches square or 5 inches all round in the hills and 1½ inches square or 6 inches all round in the plains. (2) Fixed nets, *e.g.*, *Nilotu* and *Pand*. (3) Casting nets, *e.g.*, *Sotwan, Palku, Dobajju, Weru, Soru, Pakha, and Wera.* (4) Hand Nets, *e g.*, *Kochbi* and *Saqgan* with prescribed mesh of 1 inch square or 4 inches all round; and *Dhangla* with 1½ inches square mesh or 6 inches all round. (5) Dip net or *Kurli*. (6) Fixed Engines, *e.g.*, Chip and Bar Patta (Stake net). (7) Lines, *e.g.*, Long Line with hooks (Lang or Dori), Hand Line (Dori) and Rod and Line (Bansi, Birhi, or Chheep). (8) Horse hair noose or *Kalerni*. (9) Grains or Spear (Bhala or Tirri).

37. On the development of the Vertebral Column of Urodela.

HIMADRI KUMAR MOOKERJEE, Calcutta.

Triton vulgaris is chosen as a type. The skeletogenous layer forms a perichordal tube round the notochord. With the formation of a definite vertebra the skeletogenous layer indicates clearly a re-segmentation. Intervertebral bodies have no separate origin but form a part of the perichordal tube. There is no justification to divide the intervertebral body into interdorsal and interventral. Intervertebral body divides into two as condyle and socket by the migration of a strand of connective tissue cells the directions of which determines the nature of the vertebra. Neural arch is formed not only from the dorsal arcualia but also from two connective tissue arches on either side of it. Dorsal arcualia are formed not only from the basidorsal of either side but there is a third piece, the Supradorsal. Dorsal arcualia are deflected backwards, so that the supradorsal rests on the roof of the posterior connective tissue arch. The cartilaginous cells of the basidorsal together with the inner perichondrial layer degenerate. The neural spine is formed as a mid-dorsal projection of the anterior connective tissue arch. All these become osseous, so that the adult vertebral arches are very thin comparatively. In the tail region there are connective tissue arches on either side of the ventral arcualia which has a third piece, the Infraventral. The haemal spine projects from the mid-dorsal roof of the anterior connective tissue arch. There is also degeneration of the basiventrals like basidorsals. Between the occipital arch proper and the atlas arch proper, there is an intercalated arch the division of which forms the occipital condyles and the cups of the atlas vertebra and the intervertebral body at this region forms the so-called odontoid process.

38. On the development of the Vertebral Column of Anura.

HIMADRI KUMAR MOOKERJEE, Calcutta.

Rana temporaria, *Bufo melanostictus*, *Bombinator igneus*, and *Xenopus lævis* are chosen as different types. Centrum is formed by a part of the perichordal tube formed by the skeletogenous layer which is very thin in the vertebral region, so that it looks apparently that the dorsal arcualia sit directly on the sheath of the notochord. Intervertebral bodies are a part of this perichordal tube. As the centrum is not formed from the dorsal arcualia the original modes of formation of centrum and its classification cannot stand, viz., the epichordal and the perichordal modes. In the cases of the first two types, the whole of the perichordal tube chondrifies and ultimately ossifies. In the cases of the latter two types, the dorsal portion of the perichordal tube condrifies and ossifies, the rest degenerates in membraneous state. In the case of *Xenopus lævis* there is a rectangular-shaped cartilage, formed by the chondrification of the mid-ventral portion of the perichordal tube throughout the whole vertebral column, which degenerates ultimately. The division of the intervertebral bodies and the formation of the atlas vertebra are almost the same as those of the Urodela.

39. The Structure of the Larynx in *Cacopus systoma* Schneid.

L. S. RAMASWAMI, Bangalore.

(Communicated by Mr. C. R. Narayan Rao.)

The larynx of *Cacopus systoma* is comparatively a big organ measuring only slightly less than one-fifth of the total length of the animal. Of the various South Indian Batrachians examined, this is the only form in which the pharyngeal (œsophageal) process of the cricoid is absent from both sexes, though in *R. hexadactyla* the males approximate this condition. There are two pairs of vocal cords; the principal one homologous with that of the other frogs stretch from the pharyngeal to the cardiac ends. The tracheal chamber is divided into two by a membranous fold extending from the articular process of the cricoid to the principal vocal cords and the chambers thus produced open into the glottis through canals below the secondary cords. Besides the cardiac portion of the cricoid gives attachment to two muscles hitherto unnoticed in other batrachians and they are inserted or become part of the back muscles. These are divaricators whose contraction must have the effect of enlarging the tracheal chambers. On either side of the secondary vocal cords there is an additional fairly large conical cartilaginous outgrowths which receive similar outgrowths of the same consistency on the membrane continuous with these cords. The whole apparatus is an excellent mechanical contrivance for producing the enormous volume of booming cries which *Cacopus* emits during the breeding season, and which can be heard from a radius of 2 miles. The single large gular sac besides being a house for the storage of air during croaking, serves to increase the surface area which acts as a resonator.

40. The Posterior Lymph Hearts of Some South Indian Batrachians.

A. Narayana Rao, Bangalore.

(Communicated by Mr. C. R. Narayan Rao.)

The paper describes the number and topographical relations of the posterior Lymph Hearts of both aquatic and terrestrial examples of frogs; their number and relations to the blood-vessels are noticed; the interest of connecting the multiplicity of the lymph hearts where they occur in frogs with the Urodeles is considered. The tentative conclusion is reached that the reduction in the number of lymph hearts in Anura may have something to do with the absorption of tail during metamorphosis which affects both the anatomical conditions and the life habits of Batrachians. The variations in the relationship of the posterior lymph hearts and the veins into which they open have been treated, and in *Cacopus systoma* and *Bufo melanostictus*, the modification of vena iliaco communicans to constitute a new vessel with totally different connections from what one notices in *Rana esculenta*, is dealt with and similarly other modifications of this vein in the remaining examples, though less profound are also commented upon. The size of the posterior lymph hearts seems to some extent correlated with the general habits of life, but is independent of the individual dimensions. The main interest of the paper lies in the fact that, since Beddard demonstrated multiplicity of posterior lymph hearts in *Xenopus*, the discovery is extended to some examples of *Rana* also. The variations in the formation and relationship of vena iliaco communicans to the femoral, sciatic, and renoportal and the kidney constitute another set of fresh facts.

41. On two cases of malformations in the Vertebral Column of the common Bengal toad, *Bufo melanostictus*.

Debiprosad Roy Choudhury, Calcutta.

First Case. All the vertebræ were more or less normal in form, but the bony column was shortened up owing to the crowding together of a few posterior vertebræ, and the diapophyses of the 5th to the 8th vertebræ were thinner than those of the normal ones.

The 8th vertebra was deformed. Between this and the sacral vertebræ a small process was wedged in on the left side, which probably represented half of a vertebra, and in consequence of this the horizontal plane of the sacral vertebra lay obliquely to the vertical plane of the Urostyle.

Second Case. There were 10 vertebræ in addition to the Urostyle, which was less developed than the normal one.

The 9th and the 10th vertebræ together constituted the sacrum; the former vertebra had the left diapophysis very well developed, which gave attachment to the ilium of its side, whereas its right diapophysis was reduced to a mere small spinous process. In the 10th vertebra the condition of the diapophyses was reversed—the right one was as much equally developed as the left one of the 9th vertebra, and the ilium formed connection with the expanded right diapophysis. There was a *single right* posterior Zygapophysis on the 9th vertebra which fitted with the corresponding prezygapophysis on the 10th vertebra.

The sciatic plexus was formed by the 8th, 9th, and the 10th spinal nerves. In addition, there was the so-called 11th spinal nerve which was very fine, and had similar distribution as the true coccygeal nerve of normal toads, and it took its origin apparently from the ganglion of the 10th spinal nerve.

42. On the Vascular System of a South Indian Chamæleon.

BIRENDRA KUMAR MITRA, Calcutta.

43. Note on the Venous System of a common Bengal Lizard, *Calotes versicolor.*

BIRENDRA KUMAR MITRA, Calcutta.

In the last session of the Science Congress the author (jointly with Dr. B. K. Das) described the arterial system of the lizard, and having now further data in possession he proposes to deal with the venous system. The main points are as follows:

(a) The tracheal vein is very well developed on either side, and is homologue of the Vena pharyngea of the Urodeles.
(b) There are sinus-formations in connection with some of the anterior veins.
(c) There are two prominent Azygos veins.
(d) The Post caval is formed by the union of the two renal efferent veins, which also fuse posteriorly to give rise to a median renal efferent vein.
(e) The Hepatic portal system is chiefly formed by the inclusion of the portal vein, the anterior gastric vein, the anterior abdominal vein, and the Epigastric system of veins.
(f) The anterior abdominal vein is very short, and presents primitive features, *viz.*, the two pelvics (homologues of the Lateral veins of Elasmobranchs and Urodeles) remain separate over the greater part of their lengths.
(g) The association of the common Iliac vein with the renal portal vein is of a primitive character.
(h) The presence of double venous loops—one belonging to the Renal efferent system and the other to the Epigastric system of veins—is a peculiar feature.

44. The natural history of *Calotes versicolor* (Dand.).

J. J. Asana, Ahmedabad.

Kelaart, Murray, Günther, and Boulenger have given short notes on the external characters, coloration, and a few details regarding habits. The writer has attempted to give a fuller account of the life history.

Boulenger records the size from snout to vent four and a half and the tail eleven inches long. Some of our Ahmedabad male specimens measure snout to vent six and the tail thirteen inches long.

From observations in the laboratory and the field supported by some observations of Mr. McCann of the B.N.H. Society the writer is inclined to the belief that in the cold weather a sort of torpor comes over this lizard.

The species has a definite, well-marked breeding season commencing about the third week of May lasting till the first or second week of September as ascertained from (1) observations in the field, (2) the determination of the incubation period in the field and in laboratory experiments, (3) the study of the cyclical growth or seasonal variation of the gonads.

There is evidence to show that there are individuals in this species who lay their maximum of eggs more than once in the breeding season. Kelaart and Günther both record five as the minimum, while eight is the maximum according to the former. In no case have we taken less than eleven and more than twenty-one forming a batch; nor have we once recovered eggs from the hollows of trees as recorded by a previous observer.

45. Notes on a pair of abnormal diverticulæ of the gizzard in a pigeon (*Columba intermedia* Strickl.).

S. K. Dutta, Allahabad.

The writer in this communication proposes to describe an abnormality of the gizzard of a female pigeon. The abdominal viscera of the pigeon show all the normal features except with respect to the gizzard. From the lateral walls of the gizzard there originate two slightly convoluted blind diverticulæ measuring 15 mm. in length and 8 mm. in breadth. The lumen of each diverticulum communicates with that of the gizzard by a small aperture. Passing upward and slightly outward the two diverticulæ penetrate the kidneys of the respective side between the middle and posterior lobes and become attached to the ventral surface of the ilium (pelvic girdle) by a connective tissue ligament.

46. Notes on the Cyclopian eye and other deformities of the head in a pig (*Sus cristatus* Wagn.).

S. K. Dutta, Allahabad.

The body of this monstrosity of the pig is covered with very fine bristles and shows a fairly normal structure with well developed limbs and tail. The neck is short and supports an extremely remarkable head. The muzzle of the face is curiously small and is bent upward. The jaws are, therefore, unusually shortened and so is the mouth. The external nares which are so conspicuous structures in a normal pig are altogether absent. There is only one Cyclopian eye which is apparently a product of the fusion of the two eye balls (Synophthalmia). It is a median structure situated at the base of the forehead. The dome of the Cranium is perfectly round almost like that of the skull of a monkey. The two external ears are quite normal.

The internal structure of the head has been worked out and described in detail.

47. On the structure of the Teeth of *Loris lydekkerianus.*

B. R. SESHACHAR, Bangalore.

(Communicated by Mr. C. R. Narayan Rao.)

The paper sets forth a comparison of the dentition of the South Indian *Loris* with that of some of the African forms and then proceeds to record the condition of enamel in the upper incisors, the external orifice of the pulp cavity in almost every tooth except the upper incisors, the development of the dentine tubules and their penetration into the enamel. Here a comparison is made with *Galago* with which Carter compares the teeth of the *Loris* he had examined. Attention is drawn to the two types of dentine tubules and their relation to the enamel. So far as the present writer is aware some of the structural peculiarities noted above are both new and remarkable and the problem of tracing them to the embryos is now engaging his attention.

48. The urino-genital system of *Loris lydekkerianus.*

A. SUBBA RAU *and* S. HIRIYANNIAH, Bangalore.

The Urino-genital system of *Loris lyddekerianus* presents many interesting features.

In both the male and female specimens the kidney has more than one pyramid. There is a well-defined trigonum vesicæ in the bladder. In the male, the urethra does not traverse the substance of the prostate which is unilobular, and the seminal vesicles open on either side of the Colliculas seminalis behind the orifice of the ductus deference situated near the caudal end of the crista. There is no ductus ejaculatoris. There is a well developed Os-Penis.

In the female the urethra traverses the clitoris. The uterus is bicornnate and the cervix is more or less indistinguishable from the vaginal canal. The fallopian tube does not occupy the free border of the broad ligament. The ovary is situated in a fossa which may be referred to the second type of ovarian fossa described by Arthur Robinson.

In connection with the external genitalia it should be observed that in both sexes the superficial and deep transverse muscles are absent.

The testes descend into the scrotum only during the breeding season.

49. Histology and some aspects of the neuro-muscular mechanism in the gills of *Pecten.*

S. B. SETNA, Bombay.

The gills of *Pecten* possess a neuro-muscular mechanism which is independent of the rest of the body so that excised gills when stimulated react in the same way as an attached gill.

To all kinds of mechanical stimulation whether they are tactile stimulation or mechanical vibrations, the gills are very sensitive, they are surprisingly responsive to the latter.

The gills possess two very distinct reactions.

(*a*) Flapping action, the primary function of which is to help in transfering the larger particles on to the crests of the ordinary filaments.

(*b*) Concertina action, which helps to get rid of the bulk of the larger particles.

The excision of the branchial nerve stops concertina action, the flapping action is independent of the main nerve trunks and resides in the filaments themselves.

The gills in *P. maximus* are sensitive also to chemical stimulation and the region of greatest sensitivity is the osphradial ridge. Concerning the neuro-muscular mechanism, there can be no doubt that it is a type of activity which enables the gill to select its food (quantitative), intensity of stimulus determining the path of the food particles on the gill.

50. Studies on the Chromosomes of Indian Acridiidæ.

J. J. ASANA, Ahmedabad.

The work of McClung, his students and other investigators on the chromosomes of Acridiidæ, particularly on the American genera, has shown that, barring a few variations a common, fundamental chromosome complex of a definite and precise organization exists in this family. And this is evinced by remarkable similarities in number, size, form, fibre attachment to the spindle, and the metaphase grouping of chromosomes of this complex throughout diverse genera and sub-families of not only Acridiidæ but other Orthoptera as well.

The writer has studied the Indian material with the following results :—

Sub-Family Pyrgomorphinae. This has not been studied by previous investigators. It is largely an Old World group. The writer observed a remarkable difference in chromosome numbers in contrast with the uniformity prevailing throughout all the other sub-families.

The spermatogenesis of one representative of each of the following Indian genera has been studied, *Poecilocera, Colemania*, and *Chrotogonus*. The diploid number of chromosomes in the males in *P. picta, C. sphenarioides*, and a species of *Chrotogonus* is uneven and 19, forming nine pairs of autosomes and one unpaired sex chromosome. Chromosomes in these 3 different genera show, besides similarity in numbers, shape, size, and features common to individual chromosomes which are characteristic of this sub-family.

Sub-Family Catantopinæ. In the males of *Hieroglyphus nigrorepletus*, Bol. the diploid number is 23, forming eleven pairs of autosomes and one unpaired sex chromosome. Of the eleven pairs three are the smallest.

51. Golgi Apparatus in Hydra.

EKENDRANATH GHOSH, Calcutta.

The study of the endodermal cells of *Hydra vulgaris*, both by intravital staining with neutral red and by fixation and impregnation with osmic acid (Nassonow's modification of Kalatchev's Method) shows that the vacuolar system of the endodermal cells is surrounded by granules, often running together into filamentous structures after fixation, which represent the Golgi bodies. Similar granules and filaments are also found in the thick mass of cytoplasm on the inner side of the vacuoles. The walls of the nematocysts also stain red with neutral red and black with osmic acid, showing that they also represent the Golgi bodies.

52. The Origin of Yolk in the Crustacean Egg.

VISHWA NATH *and* DES RAJ BHATIA, Lahore.

So far as the cytoplasmic inclusions are concerned the first paper on the Crustacean egg is that of King (1926). Working on the Isopod *Oniscus* with the most modern technique this worker arrived at conclusions with regard to the origin of yolk which were more or less similar to the findings of previous workers on eggs in general. According to King there are in the egg of *Oniscus* two types of yolk, namely, fatty and albuminous having Golgi and Mitochondrial origin respectiv ely. Recently, however, Harvey (1929), working on the egg of a crab has arrived at conclusions which are very much at variance with those of King and a host of previous workers on widely different materials. According to this worker fatty yolk arises independently in the cytoplasm and the proteid yolk has a Golgi origin. Although differences in the details of the origin of yolk in the eggs of allied forms are not unknown (see Nath 1925) we considered it desirable in view of the somewhat novel claims of Harvey, to investigate the oogenesis of the common fresh-water prawn of Lahore. The work was started in the month of June and is now in progress.

53. Cytoplasmic Inclusions in the Oogenesis of *Ophiocephalus punctatus.*

DHARAM NARAIN, Allahabad.

The Golgi apparatus can be seen in the juxtanuclear position in a very young oocyte. Later, the mass increases in size and resolves itself into very minute Golgi spheres or rods which gradually disperse in the cytoplasm.

There seems some indication of the infiltration of the Golgi bodies from the follicular epithelium into the egg.

The granular mitochondria arise also in the juxtanuclear area and with the increase in size of the oocyte they get dispersed in the cytoplasm. The filamentar and beaded mitochondria also appear in older oocystes.

Yolk arises by the agency of the Golgi bodies by swelling of a Golgi granule, or by disposition of new material on the concave side of one or more crescentic golgi bodies. Mitochondria appear to form albuminous yolk.

54. Golgi bodies and Vacuome in *Columba intermedia.*

D. R. BHATTACHARYA *and* R. S. DAS, Allahabad.

A small piece of ovary of a very young pigeon was examined in dilute solution of neutral red (1–25,000 in physiological salt solution). In about half an hour three kinds of structures were observed in the general cytoplasm:—

(1) Golgi bodies either spherical or crescent shaped.
(2) Comparatively big refractive bodies each with 2 or 3 crescent shaped structures attached to their rims. These we recognize as Golgi yolk.
(3) Dispersed in between the Golgi bodies are red spherical bodies comparable to Parat's Vacuome or Gatenby's vacuoles.

As these red bodies are not affected by osmic acid they are in all probability structures other than Golgi bodies.

55. Infiltration of mitochondria from the follicle to the oocyte of *Columba intermedia.*

D. R. BHATTACHARYA *and* R. S. DAS, Allahabad.

In the slides prepared by Regaud' or Regaud-Tupa's method the infiltration of the mitochondria from the follicle to the egg can easily be demonstrated. The infiltration is active before the formation of Zona Radiata but gets slackened afterwards. It is only the granular type of mitochondria which have been observed to infilter from the follicle to the egg.

Section of Botany.

President:—Prof. P. Parija, M.A., B.Sc.

Presidential Address.

SOME ASPECTS OF RESPIRATION IN HIGHER PLANTS.

LADIES AND GENTLEMEN,

I am not insensible of the honour that you have done me in asking me to preside over the section of Botany nor of my ill-equipment for the position. It is customary for the sectional President to deliver an address to the section. I have chosen as the subject of my address "Some Aspects of Respiration in Higher Plants"—a subject in which I am specially interested. I have neither the desire nor the time to tire your patience by reviewing the mass of literature which has accumulated on the respiration of plants. I intend discussing only some aspects of the respiratory process according to my light and leading. But as a background to the theme I am going to discuss, I should like to state briefly the position so far as the mechanism of respiration in animal tissues and lower plants is concerned.

RESPIRATION IN ANIMAL TISSUES.

As a result of the labours of animal physiologists and biochemists among whom Hopkins, Warburg, Meyerhof, and A. V. Hill are the chief, the chemistry of respiration in animal tissues has been placed on a sound footing. Working on isolated muscles, these workers and their collaborators have unravelled the chemical process involved in respiration. It will take us too far to recount the story, however tempted one may be, how Hopkins and Fletcher noticed the appearance of lactic acid in connection with anærobic contraction and rigor in muscle, how Thunberg, and Warburg, found the influence of iron as a catalytic agent in respiration, how Hopkins discovered "Glutathione" as a carrier of Oxygen to a constituent of the muscle cell and Meyerhof independently observed the same phenomenon in the Yeast, and finally how Meyerhof by biochemical methods and A. V. Hill by measurement of heat elucidated the whole question of anærobiosis of muscle cells and their subsequent recovery in presence of Oxygen. I will just state the position briefly.

A muscle fibre is kept in absence of Oxygen. It does some work by way of contraction on stimulation and lactic acid accumulates and finally the muscle passes into "rigor".

When transferred into oxygen again, the lactic acid disappears and the muscle revives. During the recovery, the respiration as measured by the CO_2 production and oxygen intake, increases, but this increase by no means corresponds to the amount of lactic acid that disappears. In fact, comparing this excess Oxygen with the quantity of lactic acid that has disappeared, it is found that the Oxygen disposes of 3–4 times as much lactic acid as could have been oxidised by it into CO_2. The explanation fully supported by experimental work is that the major portion of the accumulated lactic acid has been built back into the precursor of lactic acid, *i.e.*, glycogen through the intermediate stage of *Hexosephosphate.* This process has been named oxidative recovery and as we shall see later, F. F. Blackman calls the analogous process in plants " Oxidative anabolism ". The " rigor " of the muscle is due to the accumulation of the lactic acid, because if lactic acid is removed by suspending the muscle in an oxygen-free solution so that the lactic acid can diffuse away into the solution, the "rigor" is not observed.

" If the muscle is working in oxygen the chemical analysis does not show anything but the consumption of glycogen just as in the resting muscles the intake of a corresponding amount of oxygen and the formation of an equal amount of CO_2." But in reality lactic acid is being produced and most of it reconverted into Carbo-hydrate and a small portion (about $\frac{1}{4}$ or $\frac{1}{5}$) is oxidised. We will not discuss here how this reconversion takes place. Meyerhof suggests that hexosephosphate serves as an intermediate product both in the breakdown of glycogen into lactic acid and in the oxidative recovery. According to him

in Anaerobic Breakdown.

1.
$$5/_n(C_6H_{10}O_5)_n + 5H_2O + 8H_3PO_4$$
$$\longrightarrow 4C_6H_{10}O_4(H_2PO_4)_2 + C_6H_{12}O_6 + 8H_2O$$
$$\longrightarrow 8C_3H_6O_3 + 8H_3PO_4 + C_6H_{12}O_6.$$

and in Oxidative Recovery.

2.
$$8C_3H_6O_3 + 8H_3PO_4 + C_6H_{12}O_6 + 6O_2$$
$$\longrightarrow 4C_6H_{10}O_4(H_2PO_4)_2 + 6CO_2 + 14H_2O$$
$$\longrightarrow 4/_n(C_6H_{10}O_5)_n + 8H_3PO_4 + 6CO_2 + 10H_2O.$$

RESPIRATION IN LOWER PLANTS.

Of the lower plants, the yeast has been studied most on account of its economic importance and yielded the most important facts. To a less extent, the bacteria too have engaged the attention of some scientists and contributed some illuminative facts. I need not repeat the main facts about yeast fermentation which are known to all of you. One point, however, needs reference here and that is the role of hexosephosphates discovered by Harden and Young. These authors found that hexosephosphate acts as an intermediate product between hexoses and the end products of alcohol and carbon dioxide. We have just seen that hexosephosphates play a similar role in the glycolisis of muscles. Meyerhof has pursued this subject further and has found that the same co-enzyme operates in both the cases. It is well known that the oxygen respiration of acetone yeast stops if the latter is thoroughly washed and starts again on adding the aqueous extract. This extract is a thermostable co-enzyme. Meyerhof had found a similar substance in muscles. When he added boiled muscle extract to the washed acetone yeast he could re-excite the yeast to oxygen respiration. Similarly, the extract of yeast can excite muscle to active respiration. This clearly shows that the same co-enzyme operates in both cases and as there is no alcoholic fermentation in muscles and this co-enzyme assists in respiration the same co-enzyme operates in fermentation as well as respiration.

Another important fact regarding the anærobic and ærobic respiration of yeast has been established. In anærobiosis yeast produces alcohol and carbon dioxide at the expense of sugar. In oxygen, no such alcohol accumulates. This led to the suggestion by Pasteur and adopted by Pfeffer that anærobic phase is common to both. Pasteur had supposed that in yeast only the products are oxidised in presence of oxygen and fermentation stops when oxygen respiration begins.

Meyerhof found by treating yeast with a solution of HCN which stops respiration but leaves fermentation unaffected that alcohol is produced by yeast in presence of oxygen. As a result of series of experiments he concludes that both in ærobiosis and anærobiosis yeast splits a certain amount of sugar into alcohol and CO_2. In presence of oxygen most of this alcohol is built back into carbohydrate.

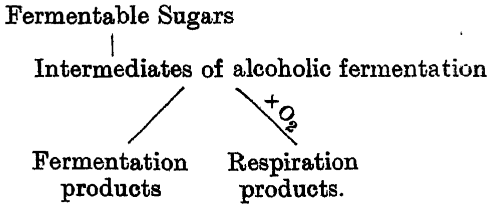
He obtained confirmation of this idea in anærobic bacteria which cause lactic acid fermentation. On adding Methylene blue the oxygen consumption of these anærobic bacteria increases three or four times and lactic acid disappears as in normal respiration. Thus the lactic acid formation is completely suppressed in presence of Methylene blue which supplies oxygen.

The position stated briefly is that in lower plants the respiratory process is analogous to that in animal tissues, *i.e.*, to say, four or five times carbohydrate is broken down of which a quarter appears as CO_2 in oxygen respiration and the rest is converted back into carbohydrate.

Higher Plants. With this knowledge of the respiratory process as a background let us now approach the respiratory processes in higher plant. A very large mass of data has accumulated on the subject. Respiration of various organs and of the whole plants has been studied at various stages of development and under various conditions. To explain these facts many hypotheses have been put forward. Even to give the briefest summary of these would occupy us too long. We have just time to pick out the salient facts and discuss some of them in light of recent work and see if we can discover any similarity in the respiration process we have described in animal tissues and lower plants, and that in higher plants. The facts that have been established can be summarised as follows :—

(1) The respirable material is carbohydrate and protein is utilised only when carbohydrates are lacking.

(2) The anærobic and ærobic respirations have a common initial phase after which, parting of the ways begins



(3) The oxidation is brought about by a catalytic system which is very likely a peroxidase and a peroxide.

According to Palladin this oxidation is brought about by chromogens, which are so widely distributed in plant tissues, as the two equations will show.

$$C_6H_{12}O_6 + 6H_2O + 12R = 6CO_2 + 12RH_2$$

$$12RH_2 + 6O_2 = 12H_2O + 12R, \text{ R being the chromogen.}$$

Very recently Keilin has tried to find out the nature of the respiratory pigments and adduces evidence to prove that cytochromes play the part of hydrogen acceptor in respiratory process. Thus he says " Cytochrome acts therefore as a carrier between two types of activating mechanisms of the cell :

(1) The dehydrases activating the hydrogen of organic molecule.

(2) The indophenol oxidase activating oxygen.

Cytochrome thus acts as a hydrogen acceptor which is specifically oxidised by the indophenol oxidase."

We have seen before that in animal tissues and lower organisms several times more sugar is split up than what appears in the form of CO_2. No such phenomena had been recorded in higher plants. In 1920 was started in F. F. Blackman's laboratory a series of studies of respiration of leaves and organs rich in carbohydrate reserves. The data gathered have thrown some further light on the course of respiration in higher plants and brings this into line with what we have seen in lower plants and animals. Of greatest interest from this point of view are the facts regarding the respiration in N_2 and in various gas mixtures. I will first give the main facts about Cherry Laurel leaves which have been extensively studied by Blackman and his students. If Cherry Laurel leaves are kept in darkness and course of respiration as measured by their CO_2 production is studied, we find that it follows a definite course. When such leaves are treated with N_2, they behave in a very striking manner. The result of substituting N_2 for air at any stage of the leaf's isolation from 0 to 200 hours is immediate and is of quite constant type, exhibiting a series of phases which take some 30 hours to develop one after another in a regular sequence (Fig. 1).

We can distinguish two variants of the form of this "Nitrogen effect"—one when N_2 is applied before 24 hours and the other when it is applied after that time. In the former, N_2 depresses respiration while in the latter CO_2 production is enhanced. In this case, the nitrogen effect has 4 phases—(1) a rising phase, (2) a falling phase, (3) a level phase, and (4) a steep falling phase which, if N_2 is continued, goes to the base, gradually getting less steep. The first two phases in late nitrogen treatment is represented by one falling phase in the early nitrogen treatment.

When leaves that have been respiring in nitrogen are brought into air again their respiration is very different from the value in air before nitrogen. The increased CO_2 production that results has been termed the "After-effect of nitrogen", although properly speaking it should be the "after-effect of anærobiosis". This effect takes the form of a steep rise to a high value which is maintained for a longer or shorter period before the respiration falls to the normal air value.

The highest intensity of respiration that is reached in each of the after-effects varies according to the period of preceding anærobiosis. After 2 hours in N_2, this value is comparatively small, the value gets higher and higher with the increase in the duration of nitrogen up to 18 hours when a limiting maximum value is reached which is not exceeded after even 48 hours in nitrogen. If all maximal intensities of after-effects from various experiments, that could be considered as sufficiently close to the limiting value, are set out against time from isolation, it is noticed that (1) these limiting rates of after-effect fall in line with the maximum rate of air respiration (Fig. 2). This identity of pitch suggests that limiting factor which expresses itself in the level phase of the air line is also operative in setting a limiting intensity in the after-effects. (2) The composite curve made up of the level phase of the air line and the line of drift of after-effect maxima runs a level course for about 40 hours and then declines. If the limiting value be taken as measuring the maximum possible efficiency of the protoplasmic respiratory mechanism at any moment, then this mechanism appears to remain intact for about 40 hours and the later decline may be attributed to deactivation of the mechanism. How this decline comes about cannot be settled off hand. From the work of Kostychev and Warburg, it may be suggested that this may be due to (*a*) deterioration of the co-enzyme which may be vitamin. or due to (*b*) lack of phosphate. Experiments on this line are necessary for elucidation of this point. (3) The striking relation that the after-effect drift and the drift of continuous respiration in air are identical for about 16 hours and then the air line drops in a sweeping curve. This fall in air line is no doubt due to starvation, *i.e.*, reduction of respirable material. At any point of the course of this starvation the air respiration can be brought up to the full possible maximum by the after-effect of a period of anærobiosis. The simplest explanation is that a large formation of respirable material occurs in air after nitrogen and immediately raises the respiration far above the starvation level to the maximum possible to the efficiency of the respiratory mechanism at the time.

Now let us consider the rate of respiration in Nitrogen. Of the four phases we regard the first two as transitional and the last as either starvational or toxic. The third level phase, therefore, can be regarded as truly representing the respiration rate in nitrogen and it has been called the equilibrated nitrogen respiration. If we put together all the equilibrated values of nitrogen respiration according to time from isolation, we get a curve exactly of the same form as the line of drift of the after-effect maxima, though throughout at a lower pitch. This curve also starts with a level course for the first 40 hours and then slowly declines. The similarity of form also indicates that fundamentally the same protoplasmic respiratory mechanism is controlling the magnitude of CO_2 production whether in nitrogen or in air.

One may be pardoned if one speculates here. The pitch of the equilibrated nitrogen respiration is 0·57 of the line of drift of the after-effect maxima. Is it possible that this fraction of the CO_2 of ordinary respiration is the product of anærobic splitting and the rest due to ærobic production ? If this is true, then follows an interesting conclusion. Assuming the analogy of typical anærobic process namely the alcoholic fermentation, one atom of carbon comes out as CO_2 for two atoms represented by an oxidisable organic product. If the whole of this were oxidised to CO_2, then the CO_2 production in air would be three times that in nitrogen, but we have just seen that the ærobic CO_2 is about double, *i.e.*, in the ratio of 1:0·57 instead of 1·7: 0·57.

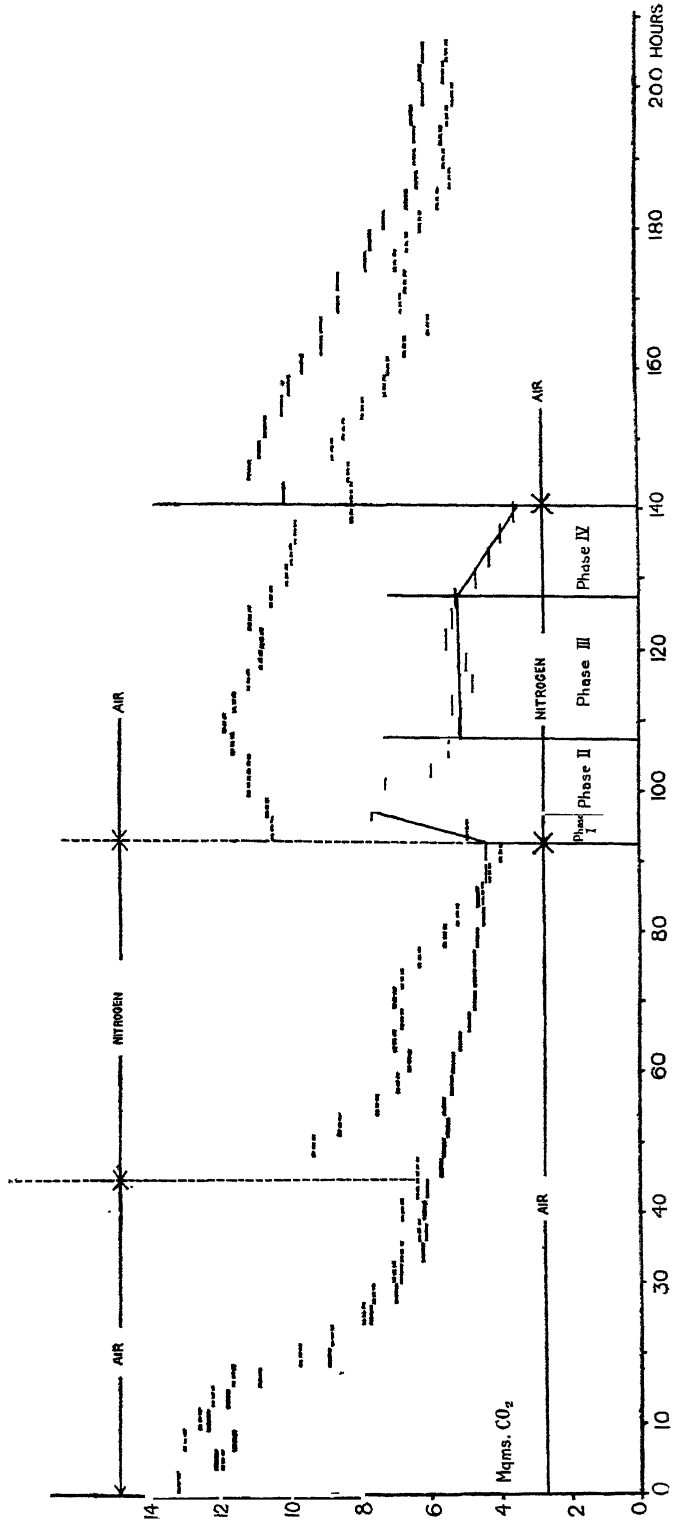


FIG. 1.—Showing the phases of respiration in N_2 and the after-effect of Anærobiosis.

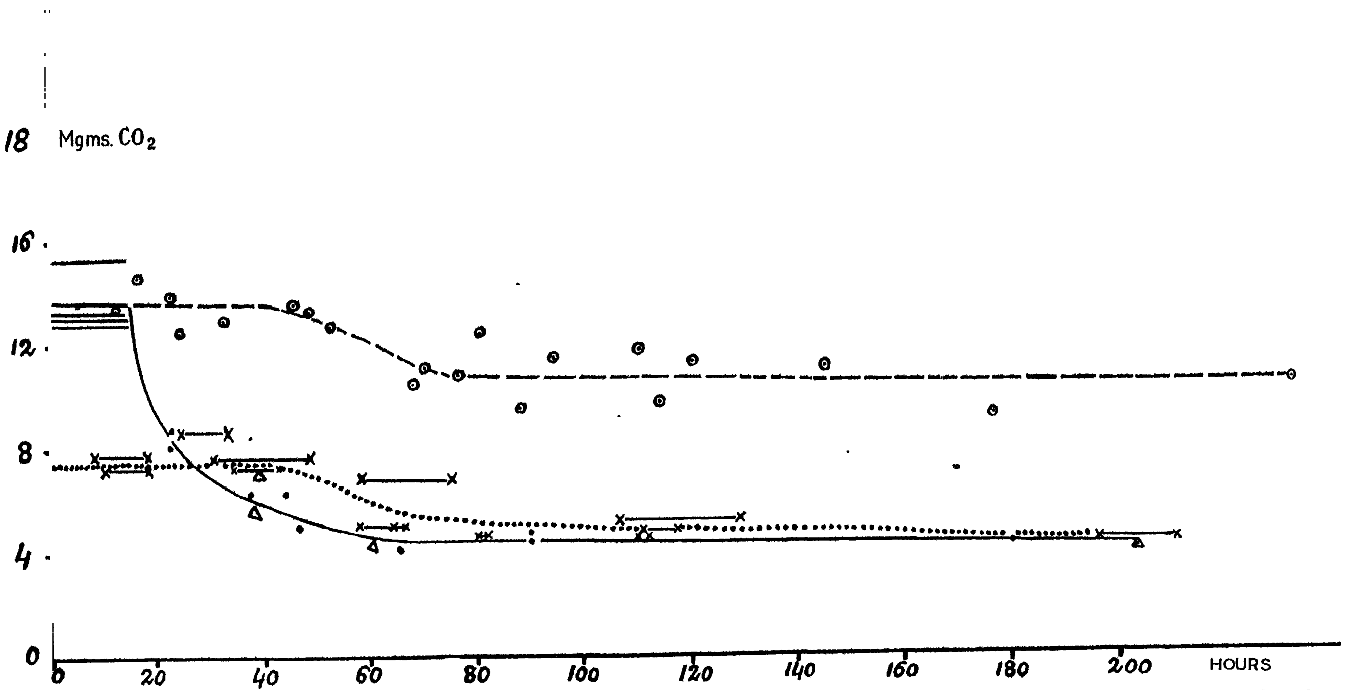


FIG. 2.—Showing the time-drift of the maximal intensities of the leaf respiration in nitrogen (dotted curve) and that of the after-effect (broken line). The continuous curve represents a typical course of respiration of starving Cherry Laurel leaves. Short lengths of continuous lines with crosses at both ends represent the equilibrated values of nitrogen-respiration, the corresponding after-effects being utilised for obtaining the time-drift of the after-effect maxima. (For explanation, see text.)

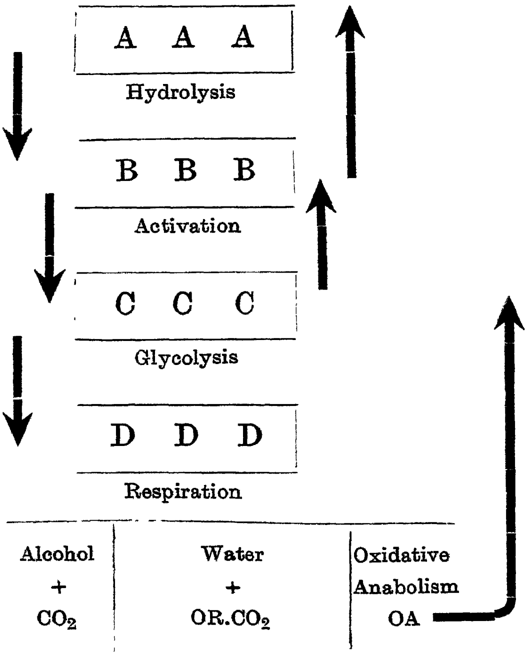
This suggests that part of the intermediate products is built back. This we shall see is further corroborated from our calculation of the total after-effects.

As we have already noted the "after-effect" is in the form of an excess CO_2 output over the air respiration, had the leaves continued in air throughout. On a graphic record this excess can be found by calculating the area enclosed between the interpolated or extrapolated air-line (the term used to denote the drift of air respiration) and the observed course of the after-effects.

When these values are compared with the total CO_2 produced in Nitrogen, it is found that broadly the ratio of the after-effect to Nitrogen respiration (NR), $\frac{A\ E}{N\ R} = 1{\cdot}12$ for nitrogen treatments lasting for 2-30 hours. But when nitrogen treatment lasts for about 48 hours, the ratios become much bigger being in one case as big as 2·01.

On the basis of typical anærobic respiration, as noted above, if 2 atoms of carbon from the sugar molecule appear as CO_2 in nitrogen then 4 atoms of carbon must be accumulating as an intermediate substance. If the whole of this substance or its carbohydrate equivalent were to appear as excess CO_2, we would expect in the after-effect twice the amount of CO_2 produced in nitrogen. But in fact we get only about an equal amount in all cases of nitrogen treatment of moderate duration. This suggests that a portion of the intermediate product is disposed of in some way other than in the production of the after-effect. The high ratio in prolonged nitrogen treatment can be explained by supposing that in some way this alternative mode of disposal of the intermediate products is adversely affected and the whole of it is oxidised into CO_2 in the after-effect.

In analysing the respiration data of apples in nitrogen and in various percentages of oxygen, F. F. Blackman has developed this idea and given a schema of glycolysis.



Without going into details, we may note that as in Cherry Laurel so in apples, we find this oxidative anabolism. Whether hexosephosphate plays any part in this anabolism is not settled. On the basis of what has been found in yeast and in animal tissues it is likely that hexosephosphate does play a part. Thus accidentally the Cherry Laurel leaves gave an "after-effect" and this led to the detection of this oxidative anabolism in higher plants. It is not all plants that give an excess of CO_2 production after anærobiosis. Thus Inamdar and B. N. Singh have carried out a number of experiments on the ærobic and anærobic respiration of leaves but they do not find any after-effect of the type in Cherry Laurel. The true after-effect is the oxygen consumption, for the intermediate product may vary in different cases.

Further interesting light has been thrown on the nature of respiratory process by allowing Cherry Laurel leaves to respire in gas mixtures containing various percentages of oxygen. Briefly stated the facts are that if we allow the leaves to respire in higher percentage of oxygen than that in air, the rate of respiration rises higher than the air rate and reaches a maximum at 33% O_2 and then slightly falls at still higher percentage of 60% O_2 and 100% O_2, though the rate is still higher than the air rate. On the other hand if we lower the oxygen percentage below that in air, the respiration rate falls below the air rate, reaches a minimum at about 5% and then rises till we reach the 0% in pure nitrogen. When the leaves are treated with percentages of oxygen ranging from 5% to 21%, there is no "after-effect" on admission of air again. The CO_2 production simply returns more or less quickly to continue the curve appropriate to respiration in air. But in the case of oxygen percentages higher than air, these strong abnormal concentrations of oxygen have a persistent disturbing effect increasing the CO_2 production for at least 24 hours after the return to air. This increased production is not, however, of the nature of the "after-effect", already mentioned. This problem is being investigated in Blackman's laboratory where respiration is being studied under high oxygen pressure.

On the other hand, if we put leaves in oxygen percentages lower than 5%, we find the respiration is lowered but when air is given again we get an "after-effect" of the type already described, though it is much smaller. Thus for 3%, the excess production of CO_2 in the "after-effect" is about half the CO_2 produced during the exposure to 3% 0_2. This led us to suppose that in 3% 0_2 two types of respiration are going on simultaneously. The CO_2 that is produced is partly of anærobic origin and partly of ærobic origin. On passing from 3% to 0%, we again cross the air line, *i.e.*, the CO_2 production is the same as in air as in a percentage of 0_2 between 0% and 3%. This explains why Stich said that respiration is unaffected in as low a percentage as 2%.

We get similar results in apples, that is to say, we get a minimum production of CO_2 in a mixture containing about 5% of oxygen.

The chief point of interest is this minimum production of oxygen in certain low percentages of oxygen. In order to explain this behaviour of CO_2 production we have to refer to Blackman's scheme already referred to. The D group of the substances which are the products of glycolysis which are wholly converted into alcohol and CO_2 in absence of oxygen. As one atom of carbon is represented by CO_2 in nitrogen respiration (NR) for two atoms of carbon in alcohol, the glycolysis is 3 NR. When traces of oxygen are present, a part of D is oxidised into CO_2 and the rest dealt with anærobically producing CO_2 and alcohol. This is substantiated by the fact that Cherry Laurel leaves after being treated with 3% 0_2 give an after-effect. .

According to this conception a percentage will be reached when the anærobic production of CO_2 will be extinguished, and the whole of the CO_2 will be of oxidational origin. This, however does not affect glycolysis nor the oxidative anabolism referred to before. But this militates against the suggestion we have made in course of this address on the strength of the maximal CO_2 production by Cherry Laurel leaves in nitrogen that a portion of the CO_2 in air respiration is produced anærobically and the rest ærobically. There is the alternative explanation that in low percentages of oxygen such as 5% and upwards a certain fraction of the final product is represented in the form of organic acid. This is not beyond probability, because it has been observed that in succulents and in certain fungi organic acids are produced as the result of respiratory oxidation. The case of succulents is specially appropriate as these have most probably a restricted supply of oxygen as a result of their morphological peculiarity. If this be plausible, then here we have experimental demonstration of what the succulents do in nature.

It is not practicable to settle the question by chemical analysis because the quantity of the substance involved is very small.

A final solution of this question can only be arrived at when we study the oxygen consumption by the tissues after they have been treated with nitrogen and various percentages of oxygen and also when we study the energy production during the various treatments and after. Both these paths of enlightenment are being undertaken with the hope that further light may be thrown on the problem.

In conclusion I must thank you for your patience in listening to what I have had to say.

REFERENCES.

1.	Blackman, F. F., and Parija, P.	Analytic Studies in Plant Respiration, I, Proc. Roy. Soc. B., Vol. 103, 1928.
2.	Blackman, F. F. ..	Analytic Studies in Plant Respiration, III, Proc. Roy. Soc. B., Vol. 103, 1928.
3.	Hill, A. V. ..	Various papers in Proc. Roy. Soc. B.
4.	Hill, A. V. ..	The maintenance of Life and Irritability in Isolated Animal Tissues. Nature, Vol. 123, 1929.
5.	Inamdar and Singh..	Studies in the Respiration of Tropical Plants. The Journal of the Indian Bot. Soc., Vol. VI, 1927.
6.	Jost	Plant Physiology, Eng. translation.
7.	Kostychev ..	Plant Respiration, Eng Translation.
8.	Meyerhof, O. ..	Chemical Dynamics of Life Phenomena, J. B. Lippincolt Company, Philadelphia and London.
9.	Meyerhof, O. ..	Address to the German Chemical Society, Ber. Deut. Chem. Ges., 1925.
10.	Parija, P. ..	Analytic Studies in Plant Respiration, II, Proc. Roy. Soc. B., Vol. 103, 1928.

Section of Botany.

Abstracts.

ALGAE.

1. Studies on the Algae of Tibet.

P. ANAND, Lahore.

During the months of July and August 1929, collections of Algae were made from Tibet, along the road from Yatung to Gyantse. The material was obtained from diverse habitats such as stagnant ponds, ditches, damp terrestial situations, cold streams, extremely cold water springs, Lakes, etc.

Zygnemales are the commonest, forming bright green masses on the surface of stagnant water.

Quite a number of collections have been made from flowing water, representing forms like Cladophora, Stigeoclonium, Oedogonium, and Palmodictyon.

A few of the floating planktonic forms such as species of Pedisatrum, Scenedesmus, Eremosphæra, Selenastrum, Cœlastrum are represented.

Ulothrix and Prasiola are also met with. Vaucheria shows a large amount of variation in the distribution, form, and arrangement of the sexual branches.

A large number of Cyanophyceæ such as species of Scytonema, Chroococus, Anabena, Oscillatoria, and Rivularia have also been noticed.

2. Organisms in the filtered water of Calcutta.

K. BISWAS, Calcutta.

During the last hot months from 1st to 10th May some reddish brown sediments were collected from tap water of Calcutta. The authorities of the Calcutta Corporation sent me materials for examination. My examination revealed the presence of iron-bacteria and algae. The most predominant vegetable matter was found to be *Lyngbya ochracea.* This alga which is often found coated with oxide of iron is regarded by Nauman as an iron bacterium—*Leptothrix ochracea.* Another iron bacterium probably *Chlamydothrix sp.?* or *Cladothrix sp.?* was found only in fragments and hence could not be identified. After cultivating the algae from these samples in the laboratory from June to September profuse growth of *Synedra affinis* var. *fasciculata* was observed in the bottles. The occurrence of *Gallionella ferruginea,* a species of spirally coiled typical iron bacteria, was rare. Another iron protozoon, which appears to be *Arcella sp.*, was also present in large numbers in the samples. Loose bundles of septate filaments of a fungus species were of frequent occurrence but no reproductive organs were found to enable one to make definite determination. Some xylem vessels and pollen grains were also observed. Among animal organisms, *Rotifers, Nematoda, Infusoria,* and *Protozoa* were noticed in considerable numbers. No trace of *Crinothrix polyspora,* suspected to be present in the material, was found. The analysis of the material showed the presence of 26.45% volatile solid, 18.48% sand and silica, oxide of iron 36%.

The investigation of these organisms of the filter-beds with a view to find out their source and methods of eradication has been taken up by the author with Rai Bahadur Dr. G. C. Chatterji, Dr. T. K. Ghose, and Mr. K. N. Das.

3. On four Burmese Myxophyceae not described from Burma before.

S. L. GHOSE, Lahore.

In this paper the following four blue-green Algae are for the first time described from Burma:—

1. *Aulosira fertilissima* Ghose. This species was first described by the writer from Lahore. In Burma it was collected from a stagnant pond in Mandalay in the month of December. In habit and structure it is quite like the Lahore form.

2. *Tolypothrix limbata* Thuret, variety *cylindrica* var. nov. This was collected from a pond in Kamayut, near Rangoon, in the month of December. In habit and structure it resembles the type form a great deal, but differs from it in two respects: firstly the cells are not barrel-shaped but cylindrical and secondly the pseudo-branching is not so copious as in the type species.

3. *Scytonema leptobasis* sp. nov. This form was collected from a pond in the Botanical Garden at Maymyo in the month of May. It lives epiphytically on aquatic phanerogams or on dead floating twigs. Two noteworthy features characterise this species. (1) The sheath is very thick and the trichome is rather narrow in comparison with it; (2) the tips of pseudo-branches are regularly swollen like those of *Leptobasis*.

4. *Rivularia natans* (Hedw.) Welw. This species was collected from Taungyi in the Southern Shan States in the month of October. It occurs in roadside ponds the water of which is continually replenished by run-in from adjacent higher places. The species has also been recorded from Lahore by the writer.

4. On the occurrence of *Nostoc sphaericum* Vauch. at an altitude of 15,000 ft. above the sea-level.

S. L. GHOSE, Lahore.

In July 1926, Professor S. R. Kashyap collected some specimens of *Nostoc* from Manasarowar at a height of 15,000 ft. above the sea-level. He very kindly gave me the privilege of examining them. The forms resemble the species *N. sphaericum* Vauch. Stratum more or less rounded and yellowish; filaments thickly floccuous; sheaths mostly absent; cells small, barrel-shaped or rounded, $=4-5\mu$ broad: heterocysts roundish, about 6μ in diameter; spores not seen.

In some cases, on the outside of the colony was found a layer of Bacteria and numerous heterocysts (without filaments), which shows that heterocysts are more durable and more resistant to Bacteria than the ordinary vegetative cells.

The species has been recorded from most of the European countries, America, Alaska, Australia, and Burma. It thus seems to have a very wide distribution.

5. Contributions to our knowledge of the fresh-water algae of Manipur, Assam.

K. P. BISWAS, Calcutta.

After the publication of the monograph, on the "Algae of the Loktak Lake" by Paul Brühl and K. Biswas, published in the Memoirs of the Asiatic Society of Bengal—Vol. VIII, No. 5, pp. 257–316, 1926, I received from Dr. S. L. Hora, Superintendent, Zoological Survey of India, a few interesting forms of rapid water algae from the swiftly flowing streams and waterfalls of the Manipur valley collected in 1920. Two bottles of algal specimens were also presented to me in 1925 by Mr. S. N. Bal, Curator, Industrial Section, Botanical Survey of India. A few of these specimens were sterile and could not be identified. All the five species with their varieties mentioned in this paper appear to have been reported for the first time from India and *Spirogyra setiformis* var. major, may be regarded as a new variety. Systematic position of the *Cladophora glomerata*, *C. crispata* and *Spirogyra setiformis* has been discussed.

6. Notes on Characeae from the Bombay Presidency.

S. C. Dixit, Bombay.

The notes are in continuation of the abstract of the writer's paper read at the Lahore Sc. Congress, 1927. The writer has shown there seven species of Characeae existing in the Island of Bombay. One of the species mentioned there as *Chara macropogon* is found on further investigation to be *Chara succincta.*

Two additional species of Chara from the presidency of Bombay are reported here.

Chara Braunii Gmelin from Cutch-Mandavi (March.)
Pashan (Poona) (September.)

Chara contraria Kütz from Jamnagar (February).
Barda Hills (Kathiawar) (March).

Both the species are found in shallow water.

The writer has further investigated and found that stem-bulbils develop in winter (Feb.-March) on *C. succincta* and *C. contraria.*

7. On the formation of secondary-spores within the pore-tubes of *Ganoderma lucidus* and *Ganoderma applanatus.*

S. R. Bose, Calcutta.

Ganoderma lucidus and *Ganoderma applanatus* are very common and cosmopolitan species, they are generally saprophytes, in some cases they have been reported as wound-parasites. Spores are found abundantly within the pore tubes, though basidia are found in *very few* specimens. After careful search J. H. White reported (Trans: Roy. Soc. Canada—1919) that there was not a single instance of conidia formation from any part of the sporophore. Examining a number of specimens I could get spores (exactly like typical *Ganoderma* spores) originating directly from the brown double walled hyphæ of the trams, such specimens had usually dispersed with the formation of basidia. So, these must be regarded as secondary spores. Such secondary spores (exactly like basido-spores) I have come across within pore-tubes of sporophores of a number of *Polypores* in artificial cultures, no basidia were found within these pore-tubes. Possibly, external conditions determine to a large extent the formation of basidia in such specimens of *Ganoderma lucidus* and *Ganoderma applanatus.*

FUNGI.

8. Wither-tip disease of Jasmine caused by *Diplodia jasmini* West.

H. Chaudhuri, Lahore.

This disease has been under observation for the last four years in Golbag, Lahore. It causes considerable damage in early spring when new twigs are formed. The central branch of the twig withers and dries up, on which later the black fructifications are formed under the dried bark. The flowers are also affected, the buds become reddish and fall off. In moist weather a kind of soft rot is produced. The disease continues from year to year in the dried twigs under the bark. When the bark peels off, the fructifications are exposed, and later spores are disseminated, spreading the disease. It could be easily got rid of if the plants are properly examined immediately after winter and infected twigs cut off considerably lower down and burnt.

The fungus grows readily in culture and has been found saltating freely in certain media.

9. On the occurrence of *Acrothecium* N. Sp. on Grape Vine, in the Government College Botanic Gardens, Lahore.

H. CHAUDHURI, Lahore.

The fungus was isolated from the leaves as well as from the twigs in February last. It caused leaf spots which spread very rapidly and brownish patches were formed on the twigs. The fungus grew readily in culture and cultural characters under different conditions have been studied. Inoculations on healthy leaves were successful. The fruits were not infected. Acrothecium has not been reported before on grape vines, and this species differs from all the species of Acrothecium described so far. A specific description of this fungus is given. Further cultural studies are proceeding.

10. A study of the cultural characters of a fruiting Aspergillus.

H. CHAUDHURI, Lahore.

The aspergillus was isolated from a contaminated flask containing liquid broth. It was a non-fruiting form. After several transfers in solid media, it formed a sector in one of the petri dishes. The saltant was of a lighter colour, and formed fruit bodies. When isolated, it formed fruit bodies plentifully in a number of media and saltated many times. Almost white fruit bodies have been found. The original and saltants were grown under different environmental conditions and the original and the saltants have been found to saltate more freely under certain conditions. Also under certain conditions it has been possible to reduce the fruiting saltant to the original sporing but non-fruiting form.

11. On a disease of *Citrus malta* caused by *Verticillium tubercularioides* Speg.

H. CHAUDHURI, Lahore.

This Verticillium was isolated from a twig which showed wither-tip disease (*Colletotrichum gloeosporioides* Penzig), and cultivated in artificial culture media. It grew in a variety of media. In nature, this fungus disappeared with the rise of temperature in early summer. In culture, it is found to tolerate a higher temperature than when it is growing under natural conditions. The fungus from the culture could infect only very young twigs in early spring and then through wounds only. The damage by this fungus on malta must be very little.

12. Wither-tip disease of the citrus plants in the Punjab.

H. CHAUDHURI *and* GOPAL SINGH, Lahore.

Wither-tip disease of the Citrus plants due to *Colletotrichum gloeosporioides* is of world-wide occurrence and attacks all the species and varieties of Citrus. In Punjab, the disease is very common and causes a good deal of damage. The trees that are badly attacked become weakened in vitality and produce a low crop. Sometimes it causes a considerable loss by inducing the fruit to fall off when they are still very young.

The characters of the fungus have been studied under natural conditions as well as in artificial cultures. It has been found that the fungus lives from year to year in the dead tissues and their presence in the orchard is the source of infection. The disease spreads most under humid conditions. All the species of Citrus found in the Punjab have been studied and the authors have come to the conclusion that *Colletotrichum gloeosporioides* is a polymorphic species made up of a number of strains which though morphologically similar have some physiological differences. Each strain is affected by its environments. The growth characteristics as well as the spores size are varied by the medium on which it is grown.

13. Anthracnose of chilli (*Capsium annum*) due to *Colletotrichum nigrum* E. and Halls.

HARBANS LALL GULATI, Lahore.

Characters of Colletotrichum under natural and various artificial environmental conditions are described.

The fruits are badly affected by the anthracnose, also the fruit stalks and twigs are sometimes attacked.

The mycelium of the parasite is localised in the tissue of the discoloured parts. The cells of the fruit skin become disorganised due to the action of the fungus. The fungus attacks the xylem vessels even and chokes the vessels and cuts off the water supply to the tissue of the skin.

Fructifications of the fungus are formed under the cuticle. At first there is accumulation of stromatic tissue in the epidermal cells, extending down even to the next layers. The cells are entirely destroyed and are replaced by short polyhedral fungus cells. From the outer part of the stroma conidiophores and setae arise. Conidiophores bear conidia at their tips.

Perithecia have not been found either in nature or in culture.

The author has been successful in producing rot in fruits of tomato and chilli and leaves and twigs of *Ficus elastica*, Citrus species and leaves and stem of sweet pea, by inoculating with pure culture of the fungus isolated from chilli.

The conidia germinate after 18 hours on the surface of the host tissue and produce appresoria varying in size and shape. After 48 hours appresoria are seen to penetrate the host cells by sending germ tubes. In hanging drops the conidia germinate readily in water and in nutrient solution within 6 or 7 hours. Appresoria are usually produced after 48 hours, or even later. The conidial and hyphal characters show a great variation in different media. Aerial mycelium is developed in some media in great abundance while it is absent in others. The sizes of setae and conidia vary in different media. Aerial growth of the fungus decreases with the decrease of the food material in the media. There seems to be some relationship between the time at which the acervuli make their appearance and the food supply. In higher concentrations the acervuli are formed earlier than in the lower concentrations. In lower concentrations the large number of acervuli are formed because there the conditions for the growth of the mycelium are not very favourable.

The rate of the spread of the fungus is greater in high than in low concentrations and the cultures become stale earlier in high concentrations than in the lower concentrations.

The light has inhibiting effect on the mycelial and lineal growth of the fungus. Light is essential for the formation of acervuli. Zonation in the cultures is due to the effect of alternation of day and night.

The optimum temperature for the growth of the fungus appears to be between 27° and 29°C.

14. Preliminary Observations and Experiments on *Uromyces* sp. on *Euphorbia dracunculoides.*

B. L. GUPTA, Agra.

The writer has studied *Uromyces* sp. on *Euphorbia dracunculoides,* a wild usually perennating herb on cultivated grounds. The life-history of the fungus which extends over 3–4 months only in winter has been found to be specially interesting, as the work so far carried out clearly indicates the autœcious nature of the fungus. The following spore-forms occurring on the same species within a short interval is an additional interesting feature.

Pycnidia and orange-yellow coloured Aecidia are the first to appear on special shoots with longer internodes and with smaller and broader leaves. Sometimes entire plants are Aecidial. *Uredo-sori,* deep brown in colour, appear later as a result of infection by aecidiospores. *Teleutospores* are one-celled, thick-walled and dark brown in colour. They gradually replace *Uredospores.* Peculiar orange-yellow coloured sori appear simultaneously with brown uredo-sori but they are much more resistant to heat than the latter. Whether all the above spore-forms are produced by the same mycelium is a problem that awaits further work to clear.

Inoculations with *aecidiospores* and *uredospores* always resulted in the production of *uredospores* on the same species, hence the autœcious nature of the fungus is evident. Inoculations with orange-yellow spores always resulted in the production of the same kind of spores on the same host.

Hybernating mycelium that has actually been found in the root-stocks of the Aecidial plants may be responsible for the recurrence of the rust year after year.

15. Dissemination of "powdery mildews" of cereals.

K. C. MEHTA, Agra.

It is interesting to note that the powdery "mildews" of wheat and barley can survive the summer in the hills as do the rusts.

Erysiphe graminis on wheat and barley can be successfully cultivated on the plains during winter. By the end of April the culture dies on account of heat.

Viable material of *Erysiphe* is available in the hills during the "critical period" and such material produces successful infection.

The writer saw a very bad attack of *Erysiphe* on wheat at Allahabad last winter.

Occurrence of *Erysiphe* under identical conditions with rusts of cereals during summer in the hills is suggestive of a similar explanation for their dissemination to the plains.

Such wind borne oidia may produce an epidemic in due course if the weather is damp.

16. Effect of environmental factors on the growth of certain species and strains of *Helminthosporium.*

M. MITRA, Pusa.

1. Seven species or strains of *Helminthosporium* occurring on various cultivated grasses and one on ginger have been studied.

2. The eight fungi were studied under different conditions of growth in artificial culture. The following were the main results:—

(*a*) Rate of growth depends on a number of factors, such as type of medium, amount of medium, presence or absence, of light.

There are certain strains, *e.g.*, that from ginger, which show a slow growth rate under all conditions tested.

(*b*) The effect of temperature on growth also depends somewhat on the nature of the medium. The eight fungi show a certain amount of differentiation as regards the position of the optimal and maximal temperatures for growth and as regards sensitiveness to heating.

(*c*) The macroscopic features of growth were found to vary very considerably. Details of the effects of cultural conditions on amount of aerial mycelium formation, colour formation, zonation, etc., are given in the text.

(*d*) Certain microscopic growth features show a greater degree of constancy. Though amount of sporulation and spore measurements vary a good deal, spore shape and colour are markedly constant and therefore are of value for specific delimitation.

17. Saltation in the genus Helminthosporium.

M. Mitra, Pusa.

1. Of eight species or forms of *Helminthosporium* isolated from nature, all except two (one from wheat and the other from *Panicum*) produced saltants in artificial culture. Altogether forty-eight distinct saltants have been isolated and studied.

2. New strains may arise as visible sectors. The tendency to sector formation is greater in shallow than in deep plates.

3. More frequently saltants have arisen as isolated patches scattered over the surface of the parent culture. Such areas of differentiation may or may not show a visible difference from parts which reproduce the parent type. The frequency of their occurrence is greater in old cultures, in cultures grown on rich media, and in cultures maintained at about the optimum temperature for growth. The interest of these observations from the point of view of keeping stock cultures is pointed out.

4. A comparison between each parent and the saltants derived from it has led to the following conclusions:—

(*a*) Macroscopic characters (including intensity of sporulation) are extremely variable; so much so that scarcely any taxonomic value can be ascribed to them.

(*b*) There is also a good deal of variation as regards spore size and septation though the majority of saltants tend to resemble the parent form in these respects. The shape and colour of the spore are fairly constant.

(*c*) According to a preliminary test, there is a considerable range of parasitic vigour shown by various saltants of *H. sativum.*

18. The cultural study of 2 fungi found in an Indian hill apple.

J. H. Mitter *and* R. N. Tandon, Allahabad.

1. The fungus found in the soft rot of a hill apple was isolated by growing it on Brown's starch medium.

2. Healthy hill apples were inoculated with the isolated fungus which in about 3 weeks caused a rot from which the original fungus was re-isolated.

3. Colonies of the fungus on Brown's starch plates showed two distinct parts which being separated by means of sub-cultures proved to be

two distinct fungi A and B which differed from each other with regard to morphological features and growth rate.

4. The fungus A did not spore. B produced Pycnidia submerged in the medium and was identified as being in all likelihood a species of Sphaeropsis.

5. A second and third apple inoculation experiment showed the much stronger parasitic power of Sphaeropsis sp. as compared with that of A.

6. Sphaeropsis on apples in India does not appear to have been recorded previously. A detailed study of the disease, should it be of common occurrence in orchards in India, might be very useful.

19. Fungus flora of Allahabad, Part II.

J. H. MITTER *and* R. N. TANDON, Allahabad.

A list of the fungi of Allahabad was published by Kanhya Lal Saksena in 1927. His observations extended over a few months only, and a number of other fungi have since been collected by the authors who have prepared part II of the fungus flora of Allahabad. The area under review was limited to the fields, parks, and gardens of the town only.

This list includes a total number of 84 fungi. The number in each of the large groups is given below.

Phycomycetes	12
Ascomycetes	11
Uredinæ	9
Ustilaginæ	2
Fungi imperfecti	50

The Eu-Basidiomycetes of Allahabad were not collected and identified because the rains were poor in 1928 and the Mushroom crop was consequently not rich in new forms.

20. Fungus Flora of Allahabad Part I (Revised). *Uromyces Andropogonis-annulati* Syd. et Butl. nov. spec. on a new host, *Andropogon pertusus* Willd.

KANHAIYA LAL SAKSENA, Gwalior.

A collection of the fungi of Allahabad was commenced on the 15th of August 1926. Since that time both parasitic and saprophytic fungi have been collected. Excursions were made regularly and very possible type of locality was inspected. In all one hundred and seventy five specimens were obtained up to the 15th of April, 1927. Of these, 50 were fully named, being run down to the genus and species, while in the case of another 50 only the genus was discovered.

Some of the parasites collected are serious fungoid pests and cause considerable damage to the crops concerned. Amongst these may be mentioned *Puccinia graminis* on wheat, *Sclerospora graminicola* on Bajra (*Pennisetum typhoideum,* Rich), *Ustilago Hordei* (Pers) Kell and Swin on Barley (Jau), *Melampsora Lini* on *Linum usitatissimum* (Ulsi), *Tolyposporium Penicillariæ* on Bajra.

During the rains! many *Basidiomycetes* (Toadstools, mushrooms, etc.), were available. Some of these, such as the umbrella fungi (Agaricinæ) and *Scleroderma vulgare* grew on the soll while others such as *Auricularia sambicine, Hydnum, Sterium, Favolus, Schizophyllum commune* and *Fomes lucidus* were found growing on dead wood or at the base of living trees.

The previous classification was based on " Clements Genera of Fungi" and therefore *Uredinæ* and *Ustilaginæ* were put under *Ascomycetes* but according to the revised classification based on Gwynne Waughan and Barnes, they have been included in the *Bassidiomycetes.* The number in each of the large groups is given below :—

1. Phycomycetes	5
2. Ascomycetes	14
3. Bassidiomycetes	45
4. Fungi Imperfecti	36

Out of these, the following are of special interest as they have been recorded for the first time on their hosts :—

(*a*) Dimerium sp.	On Cordia myxa.
(*b*) Uromyces Andropogonis annulati Syd., et Butl.	On Andropogon pertusus Willd.
(*c*) Ultilago sp.	On Apluda varia.
(*d*) Cercospora sp.	On Hibiscus cannabinus.

A detailed study of *Uromyces Andropogonis annulati* Syd. et Butl. was made and it was found that the structure agrees with fungus described by Sydow and Butler on *Andropogon annulatus* but for slight differences in the size of spores, etc., which may be due to (*a*) change of host and (*b*) change of environment and therefore negligible. Thus I conclude that *Uromyces Andropogon annulati* Syd, et Butl. nov. spec. also infects *Andropogon pertusus* Willd, on which it has not been previously recorded and causes considerable damage to this excellent fodder grass.

21. Studies in the genus *Cercospora.* (1) Morbid anatomy. (2) Changes undergone by four different species of *Cercospora* when grown on four different culture media.

U. B. Singh, Allahabad.

Species of *Cercospora* cause leaf spot disease in plants. This fungus is a hemi-parasite and permeates the tissues of the leaves both between and across the cells. The length of the conidiophores and conidia is variable and to some extent dependent on humidity relations.

A comparative study of four species of *Cercospora* is given, considering chiefly the macroscopic characters (colour and nature of the colony, colour of the substratum and the nature of growth), Microscopic characters, the rate of radial advance, spore measurment, and septation mode.

The following results were obtained :—

The four species of *Cercospora* selected for study with the symbol used to denote them, are as follows :—*C. Patouillardi* Sacc. et D. Sacc, on *Calotropis procera* CP, *C. Feuilleauboisii* Sacc, on *Solanum nigrum* CF. *C. leucosticta* on *Melia Azedarach* Cl. and *C. Cajani* CS.

CP and CF show highest rate of growth on Potato-glucose while Cl and CS show greatest rate of growth on Prune agar. Only CF failed to form conidiophores and conidia on any of the media used. Only one saltant was obtained and that was from Cl grown on malt agar. The saltant was sterile and its rate of growth was greater than that of the parent. There is a strong correlation between the septation mode of the spore and the degree of staling shown by the colony in the culture media used. The non-staling type of growth is associated with high septation mode; while the staling type of growth is associated with low septation mode. This has been seen not only as regards different species on the same medium, but also as regards the same species when grown on different culture media. The septation mode of all the species of Cercospora used either remained the same on some media, or showed an increase on others. In no case was the mode lowered.

BRYOPHYTA.

22. Distribution of mosses in the Western Himalayas and the Punjab plains.

R. L. Badhwar, Lahore.

The writer visited some parts of the Western Himalayas, *i.e.*, Kumaon in 1926; Garhwal, up to Gangotri and Jamnotri in 1927; Chamba, Pangi, Lahul, Spiti, and Zanskar in 1928, with Professor Kashyap. These visits were made during June to September, and specimens were collected in these months. Collections from Kumaon and Garhwal are not sufficiently comprehensive to base any conclusions upon, but in the last excursion the writer devoted himself almost exclusively to the study and the collection of mosses from these parts.

The area visited ranged from 700 to 17,000 ft. above sea-level. The climate differs widely in different places. In the Punjab plains, the summer is hot and dry and consequently very hostile to the growth of these plants. As we pass from the plains to the mountains of the outer range mosses increase both in the number of species and individuals, till between 5,000 to 7,000 ft. they are at their best.

In Chamba valley, the climate is of semi-tropical nature near Chamba city. The heat is great and rainy season well marked. From the capital upwards conditions are more severe and vary from temperate to semi-arctic. Height for height the mosses have decreased here in the number of individuals.

In the Chandra Bhaga valley the climate is temperate in summer to arctic at higher levels in winter. The rainfall has decreased further. Individuals here are met with at long distances but the number of species is very large.

Conditions are more or less similar in the upper Chandra valley, upper Bhaga valley, Spiti, and Zanskar. The climate is very cold and dry. There are no trees and even small shrubs are scarce. Some cultivated willows are met with in Spiti and Zanskar. The winter snowfall crushes down the rocks and thus allows no time for the mosses to grow. The only mosses that are met with, with a very few exceptions, are found near water.

In the Beas valley the flora is very rich, although the rainfall is not very high.

A detailed list of mosses from these parts is given. In all 274 species were collected out of which there are 17 new species (including one new genus), besides several new records for Asia, India or the Himalayas, together with a large number of rare Himalayan species. The specimens have very kindly been named by Mr. H. N. Dixon.

23. Studies of *Ceratodon* (L) Brid. and *C. Conicus* Lindb; and *Bryum argenteum* L, and *B. argenteum* var. australe Remh.

R. L. Badhwar, Lahore.

The writer after examining several specimens from different heights and from different climatic conditions has come to the conclusion that there is no justification in separating the two species *Ceratodon purpureus* (L) Bird and *C. conicus* Lindb. For similar reasons the writer holds that *Bryum argenteum* var australe Rehm cannot hold its varietal rank. There are intermediate forms between the two types in each case.

24. A list of the liverworts found in the Kashmir valley.

R. S. Chopra, Lahore.

A list of the liverworts found in the Kashmir valley is given at the end of "Liverworts of the Western Himalayas and the Punjab Plain" by Professor Kashyap. The list is said to be incomplete. Recently, Mr. Amar Chand Joshi collected a number of specimens given in the above-mentioned list, the collection contains the following species not given there :—

1. *Conocephalum conicum* (L) Neck. Fairly common.
2. *Sauchia spongiosa* Kash. Konsar Nag, 12,000 ft.
3. *Fimbriaria* Sp. Konsar Nag, 12,000 ft.
4. *Riccia* Sp. Konsar Nag, 12,000 ft.

A few more specimens from the same valley are being examined.

25. A note of West Himalayan *Frullanias* and *Madothecas.*

R. S. Chopra, Lahore.

Many specimens of these genera have been collected by Professor Kashyap during the last twenty years and by the writer during the last three years from various parts of the Western Himalayas.

The collection contains the following species of *Frullania* :—

F. squarrosa Nees.
F. polyptera Taylor.
F. gracillima St.,
F. retusa Mitt.

Of the four species, *F. retusa* is the only species recorded by Stephani from the Western Himalayas. The others, though recorded by him from other parts of India, are not recorded from this region. Dr. Verdoorn who has kindly identified the *Frullanias* has made a new variety of *F. squarrosa* from the collection and named it *F. squarrosa* var. *planescens.*

The collection contains several species of *Madotheca*, of which the following have been studied :—

M. ovalifolia St.
M. ovalis G. ms.,
M. Gollani St.
M. sp.
M. macroloba St.
M. appendiculata St.
M. sp.
M. sp.

M. ovalifolia is not recorded by Stephani from the Western Himalayas. There are at least three new species. There are several other species that are probably new but they have not been fully studied.

26. The liverwort flora of Sikkim.

S. R. Kashyap, Lahore.

The country was visited during July and August, 1929, and specimens were collected from the lowest levels to about 15,400 ft. on the top of the Jelep La and Nathu La.

The liverwort flora is very rich, especially the foliose forms, though the thallose forms also occur in great abundance in many places. The specimens are being worked out in detail.

Many of the West Himalayan species are present in this region.

An important feature is the absence of the more or less definitely tuberiferus species like *Stephensoniella brevipedunculata, Exormotheca tuberifera, Sewandiella tuberifera, Athalamia pinguis, Aitchisoniella himalayensis,* and others. Some of these may perhaps be met with on a closer search being made.

In the case of some other species which form tubers in the West Himalayas and which occur here, no tubers were met with, *e.g., Anthoceros himalayensis, Fossombronia himalayensis, Cyathodium tuberosum.*

Pellia epiphylla which is very rare in the Western Himalayas and

Calycularia crispula which is not at all common, are exceedingly abundant round about Darjeeling and other places.

Frullanias and *Lejeunias* are very common.

One species (Plagiochasma sp.) was seen in Central Tibet at 13,500 ft. in the gorge before reaching Khangma; about 60 miles beyond the main Himalayan water-shed.

A complete list is being prepared.

27. A short note on some interesting abnormalities in a species of *Polytrichum* collected from Darjeeling in June, 1929.

G. P. MAJUMDAR, Calcutta.

(*a*) *Prolification.*—The phenomenon is only seen in *male* plants, and has already been noted by Gœbel and Campbell. Here, the shoot is, as it were, prolonged through the centre of the original "flower" and is terminated by a second flower.

On a radial longitudinal section through a normal flower it is seen that the antheridia are arranged in groups, and that a central group is surrounded by whorls of lateral groups, each of which terminates a shortened branch. The so-called flowers may thus be regarded as really composed of distinct, but closely approximated "inflorescences". In the present case the axis instead of being terminated by the central group of antheridia is prolonged beyond the cup into a leafy shoot which, as in the normal cases, bear the flower (?) at its apex. Can we still consider all male Musci as *acrandrous* ?

(*b*) *Polyembryony.*—In this case one and the same calyptra encloses two distinct and separate sporogonia. Evidently a double embryo formation has taken place in the same venter. The author is not aware asimilar case to have been recorded before.

28. On the Liverworts of Nainital and the adjoining Hills.

S. K. PANDE, Lucknow.

This note deals with the Liverworts collected from Nainital, Bhimtal and the adjoining hill tracts.

Some of the specimens have been recorded for the first time from this locality. Others are found to exhibit morphological features of interest hithertofore unrecorded.

Ecological adaptations of these Liverworts are also discussed.

29. Further studies on the germination of Cyathodium spores.

N. K. TEWARY, Benares.

These studies relate to the germination, in hanging drop cultures, of the spores of Cyathodium from sporangia collected a year ago. The spores which failed to germinate when fresh readily germinated after a year's storage. Their germination is described and note is made of a number of interesting features.

PTERIDOPHYTES.

30. An instance of gall formation in Selaginella.

S. N. BANERJEE.

A Selaginella sp. collected from Darjeeling bears apical insect-galls. The insect of which the pupa is found enclosed in the apical globular swellings belongs to the order Diptera, family Brachycera. Instance of gall formation in Selaginella is very rare.

31. Report on the occurrence of *Helminthostachys zeylanica* Hook., and *Equisetum debile* Roxb. in the suburbs of Calcutta. (Collected in September, 1929.)

G. P. Majumdar, Calcutta.

Specimens of this genus of *Ophioglossaceæ* were found growing under the shade of trees, on clear ground. One specimen shows *forking* and a second *lateral branching* of the fertile spike. From the nature of the origin and the branching of the fertile spike the author holds with Gœbel that "the sporophyll of Helminthostachys *is* a portion of the foliage leaf".

The species of *Equisetum* was found growing wild with fructifications in all stages of development. Some of the specimens attained a length of seven feet, four feet above and three feet below ground. The horizontal rhizome giving rise to aerial shoots runs very deep in the soil.

32. Note on vegetative reproduction in the Indian Selaginellas.

M. L. Sethi, Multan.

Some new facts in regard to the vegetative reproduction in the Indian Selaginellas hitherto unnoticed are recorded.

GYMNOSPERMS.

33. Distribution of wild Conifers in the Indian Empire.

K. P. Biswas, Calcutta.

In this paper the author has noted down the different localities from which Conifers have been collected as far as available from the herbarium material of the Royal Botanic Garden and literature. A map for each of the genera showing the area of its specific distribution as also one full map showing the general distribution of the Indian Conifers have been incorporated. The distribution of the twenty-three wild species recorded here shows that the growth of the Conifers in India is mainly confined to the Eastern and Western Himalayas. The survey of the specimens of Conifers in the herbarium shows that the collection of these plants in India was started as far back as the year 1800 by Wallich, and continued by J. E. Winterbottom (1848), Dr. Stolickzka (1856), Sir R. Schomburgh (1859), Dr. G. M. Giles (1815), and others. The type sheets prove definitely that the species mentioned are all wild. A list of all the wild and cultivated Conifers in different parts of India, Burma, and Ceylon has also been appended together with the date of their introduction as far as available. The list has been compiled with the kind co-operation of the Superintendents and Curators of the various gardens and Forest Officers of the different districts of India, Burma, and Ceylon.

34. Study of the coral-like roots of *Cycas revoluta*, *C. circinalis* and *Zamia floridana*.

H. Chaudhuri *and* A. R. Akhtar, Lahore.

The anatomy and physiology of the root tubercles of above plants have been studied. The habit and external morphology of the coral roots are described and detailed anatomy given. The algae and bacteria inhabiting these roots have been studied and isolated, and characteristic features both *in situ* as well as in culture described. The mode of infection has been investigated and symbiotic relationship discussed.

35. Study of the root tubercles of *Podocarpus chinensis.*

H. Chaudhuri *and* A. R. Akhtar, Lahore.

The root tubercles of *Podocarpus chinensis* were collected in Lahore Gardens. The tubercles are formed both on the main and on the secondary roots to which they are closely applied. The anatomy and external morphology of the tubercles have been described. These tubercles are found to be caused by a non-septate fungus. The character of the fungus has been described and mode of infection and probable symbiosis discussed. Further work is still proceeding.

36. Bisporangiate Cones of *Pinus longifolia* Salis.

L. N. Rao, Bangalore.

Several bisexual cones of *Pinus longifolia* Salis, were collected by the author during April 1929, at Ootacamund, from a single tree. At the base of these cones are the scales similar to those found on the long branches of the same species. Higher up, in the axils of such scaly bracts are found several axillary male cones varying in number from 10 to 14, of different sizes but very much smaller than the normal male cones of the same age. The smallest cone being 3 mm. long and the biggest cone being 8 mm. long. Above this girdle of male cones, there is a distinct zone of microsporophylls with microsporangia, all quite normal. The length of this zone also varies. Above the male zone there is the female zone with the well marked woody bracts and ovuliferous scales.

Such bisporangiate cones have been recorded in *P. excelsa* and *P. maritima* but so far as the author is aware of, no such instance has been recorded in *P. longifolia*. Further, the presence of axillary male cones in addition to the two sets of sporophylls is interesting in this specimen.

37. Contributions to the life-history of *Cycas circinalis.*

M. A. Sampath Kumaran, Bangalore.

The paper deals with the development of the ovule till fertilisation.

38. The development of Embryo in *Gnetum scandens.*

M. A. Sampath Kumaran, Bangalore.

This paper deals with the development of the fertilised egg, suspenser and pro-embryo till the formation of the cotyledons.

ANGIOSPERMS.

39. Study of the adventitious aerial roots of *Plumiera acutifolia.*

A. R. Akhtar, Lahore.

The adventitious aerial roots of *Plumiera acutifolia* were collected from Yillwanchilli (a Railway Station on Madras, Calcutta Line), and their anatomical study was undertaken. The adventitious aerial roots arise in a coral-like manner from the sides of the branches. Structure of the normal root differs from the adventitious aerial root; the former invariably shows the secondary growth. The aerial adventitious root branches endogenously.

40. A preliminary report on the cytoplasmic inclusions in the pulvini of Mimosa, Neptunia, and Bean plants.

J. J. ASANA, Ahmedabad.

Sir J. C. Bose in his book 'Plant Autographs and their Revelations' while speaking of the agency which enables a highly sensitive plant to respond to stimulation with comparatively great rapidity, for instance, Mimosa when contrasted with Bean plant, observes that this remarkably great difference in physiological activity or functional behaviour is difficult to be accounted for on any gross anatomical difference in the structure of the motile organs of these contrasted plants. "It is not anatomical structure but the protoplasmic content of its tissue that confers on an organ its physiological efficiency. The motility of an organ is dependent on the presence of a certain active substance in the protoplasm."

The writer has investigated cytologically the pulvini of these three plants simultaneously by each of the following modern cytological methods. *Intra vitam* examination with Neutral Red in a dark room, Regaud, Da Fano, Flemming without acetic. Kolatchev and two to three other methods are being attempted.

In view of the terminological inexactitude and disputed homologies between the cytoplasmic inclusions of plant and animal cells at present prevailing in plant-cytology literature, the writer is not prepared to assign the cell inclusions he has observed to any definite categories of cell organelles.

The four methods above-named uniformly demonstrate the existence of some substance or cell organelle in almost all the cells of both the epidermis and cortex of Mimosa and Neptunia besides other bodies which are probably chondriosomes staining characteristically with acid fuchsin, and iron haematoxylin. While the chondriosomes are present in the Bean plant, the other substance is totally absent, not a trace of it being found in it. It is completely destroyed by the Bouin fixative, while the fixatives above-named preserve it in the sensitive plants where it can be clearly seen even under low powers. It may perhaps be likened to the vacuome of Guilliermond and others.

It appears as a fluid, more tough or viscid at the periphery, and seems to be broken up or pulverised in the form of small droplets in the epidermis, looking very much like regular, slightly ovoid or circular platelets. In the cortical region it is mostly in the form of a large, massive, irregularly shaped drop in each cell accompanied by droplets of intermediate and small size. All of these uniformly show a thin, deep black rim on the periphery, next to it a thin clear unstained region all round inside the rim, by the three methods Regaud, Da Fano, Flemming without acetic. While the comparatively larger innermost region in all sizes of drops, particularly in larger ones, appears clear, gold-yellow in Regaud, dark copper-coloured in untoned slides of Da Fano, and very dark brown or black in Flemming without acetic slides, which were left in turpentine for over 20 minutes. These drops or vacuomes do not take any stains, like acid fuchsin, methyl green, haematoxylin, but immediately take neutral red in vital staining.

These highly sensitive plants and other species showing autonomous movements perhaps offer an interesting field for investigation in plant cytology.

41. On the true nature of the nuclear division in old internodes of local *Tradescantia* stems.

S. R. BOSE, Calcutta.

Strasburger reported amitosis in old internodes of *Tradescantia* stems, he figured a lobed nucleus in support of it. So far as higher organisms, are concerned. Sharp has recorded that amitosis occurs in comparatively few well-authenticated cases. Constricted or irregularly lobed nuclei were in the past freely taken as evidences of amitosis. Goldstein in his recent investigations on nuclear from (*Bot. Gazette*, Vol. LXXXVI, No. 4, Dec. 1928) states that "the constricted nucleus appears more or less as if it were dividing. Such nuclei occur in the parenchyma cells of healthy green lily leaves and petioles, and are not an indication of amitosis ....Such hypertrophied nuclei with cleft, crenate, or furrowed membranes, or lobed, lobulate, or amoeboid outlines occur normally in healthy plants in special organs of nutrition, and associated with certain phases of nutritional and secretory activity." Amitosis as a normal phenomenon in healthy cells is to be differentiated from deranged mitosis occurring in abnormal tissue due to the pathological condition of the cells, in the latter condition the nuclei usually fragment and perish in the end.

To find out the true nature of the nuclear divisions, microtome sections of the longitudinal strips of old internodes from stems of *Tradescantia discolor* and *Tradescantia zebrina* were prepared; the sections revealed a number of elongated nuclei, some ridged or irregular in outline, and a few were constricted almost like the one figured by Strasburger, they were usually one in each cell. Nowhere could I find the actual breaking up of the nuclear body into two or more rounded segments. Such elongated nucleii; I could get in the cells of the ovarian wall of very young flower buds ot *Polyanthus tuberosa*. This condition is surely not an indication of amitosis, it is probably connected with the metabolic activity of the cells as has been remarked by Goldstein. In *Tradescantia virginica* stem Mons. Conard has recently (*Mem. Acad. Roy. Belgique*, Vol. 9, 1928) worked on *mitosis* in the lobed nucleii; he also considers that the constant occurrence of such irregular and fragmented nucleii in *Tradescantia* is connected with the vigour of the stems.

42. A Method of Measuring the size of Cells in the Parenchymatous Tissue of Apples and a comparison of Cell size in apples from different localities.

H. P. CHAUDHURY, Lucknow.

During the course of an investigation on apple it became necessary to find out whether the same variety of apples grown on different soils showed any variation in the size of cells in their parenchymatous tissue. Attempts were made to disintegrate apple tissue in various disintegrating fluids such as dilute Ammonium Oxalate, Potassium Oxalate, Hydrochloric acid, Cytase got from Botrytis cinerea and dilute Sodium Hydroxide, etc. Experiments showed that the best disintegrating fluid in the case of ripe or nearly ripe apples was N/20 Na OH. This disintegrating fluid was therefore used in the case of Worcester Pearmain-apple, grown in different soils. The disintegrated cells were measured under the microscope by means of an eye-piece micrometer, the length and breadth of cells being noted. The product of the length and the breadth gave the surface area which was computed on the supposition that the cells could either be taken as conformable to ellipse, circles, or rectangles. From comparison it was found out that the error introduced in taking the cells as ellipse or ellipsoid was least, being only 2-4% whereas when the cells were taken as circles or rectangles, the error can be as much as 6-10%.

The mean surface area of 100 cells of each sample were also drawn by camera lucida directly on squared paper divided in mm. or traced on squared paper from camera lucida drawings on other paper and their surface area found by counting number of squares. It was found that this method is quite a rapid one when a large number of samples have to be examined and the error introduced in such cases is less than 5%.

Applying this method it was found that the some of the soils had marked effect in altering the size of cells of the parenchymatous tissue. This change is probably due to metabolic changes brought about by the kind and amount of ions entering the plants from different soils.

43. Bacterial root tubercles of *Casuarina equisetifolia.*

H. Chaudhuri *and* A. R. Akhtar, Lahore.

Morphological and anatomical features of the root tubercles of *Casuarina equisetifolia*, collected from Elliot Beach, Madras, in January, 1929, have been described. These tubercles are not of universal occurrence. Though the tubercles occurred regularly in Madras plants, not a single case of tubercles was found in Lahore plants. These tubercles are caused by rod-shaped bacteria which are found inside the parenchymatous cells of the cortex. Infecting the soil of pots containing young Casuarina plants in Lahore with dried root tubercles from Madras failed to develop tubercles in the Lahore plants.

44. Eriocaulon of the neighbourhood of the town of Dacca.

H. K. Datta, Dacca.

Only five species, belonging to the single genus Eriocaulon, have been found, four of which are hygrophytes, and one a hydrophyte.

45. An anomalous case in the Genus ' Ottelia '.

H. K. Datta, Dacca.

A plant belonging to the family Hydrocharideæ is found growing in the marshes near the town of Dacca, which does not exactly agree with any of the known species. All the individuals bear staminate flowers only. From a comparison of its characters with those of Ottelia alismoides, there are strong reasons for supposing it to be a variety of the latter. A revision of the definition of the genus Ottelia is necessary.

46. Notes on the flora of Central Tibet.

S. R. Kashyap, Lahore.

The country between Yatung and Gyantse was visited during July and August, 1929. The vegetation beyond the Himalayan range is very similar to Western Tibet with differences in detail. The climate is much milder than that of Western Tibet. There are no trees for about 80 miles. At lower levels (below 13,500 ft., or so), willows, poplars, and hippophae are met with.

Caragana and *Thylacospermum* are not common. *Arenaria* and *Androsace* form cushions in enormous numbers in some places. About half a dozen species of *Astragalus* are very common, as also some species of *Artemisia.*

The cushion and tuft habit is very characteristic in most places. There are, however, dense carpets of grass with other herbacious plants on the banks of streams. Grass occurs in scattered tufts in other places.

47. Development of the female gametophyte of *Asphodelus tenuifolius.*

P. Maheshwari *and* U. B. Singh, Allahabad.

The development of the female gametophyte of *Asphodelus tenuifolius* is described. There is a single archesporial cell which divides to form the primary wall cell and the megaspore mother cell. The latter, after the first reduction division, forms two cells of which the lower is the larger.

The chalazal cell is the first to enter upon the second reduction division, and gives rise to two daughter nucleii separated by a transverse wall. The micropylar cell divides later, and the daughter nucleii formed may be separated either by a transverse or a longitudinal wall. In all cases the lowest megaspore functions, and the upper three degenerate. The development of the female gametophyte is normal. The polar nucleii meet in the upper end of the sac, but the fusion nucleus soon migrates to the antipodal end. The endosperm is free nuclear and the embryo follows the Lilium type. In some flowers degenerations have been observed at the four and eight-nucleate stages. A third integument or aril develops at the four nucleate stage and surrounds the ovule after fertilisation.

48. Life history of *Digera arvensis*.

S. P. NAITHANI, Allahabad.

The microsporangium is derived from the outermost layer of the periblem as is usual in angiosperms.

By periclinial division of the archesporium primary parietal and primary sporogenous layers are differentiated.

The primary parietal layer divides to form the endothecium, a middle layer and tapetum. The primary sporogenous layer divides to form spore mother-cells.

Each of the microspore mother-cells forms four spores by two successive or simultaneous divisions.

The generative cell derived from the microspore is at first spherical, later it becomes lenticular.

The generative nucleus divides into two male nucleii in the pollen grain long before dehiscence.

The origin and the development of the megasporangium and the female gametophyte is as is usual among angiosperms.

The study of fertilisation and the developement of the embryo is still being made.

49. Change of sex in the male plants of *Carica Papaya* Willd, by decapitation, observed in Deoghur (S.P., Behar).

G. P. MAJUMDAR, Calcutta.

The method is commonly practised in Deoghur to change male plants into female ones, and often with success. The author has had opportunity to observe the results of such an experiment. Out of 20 seedlings grown in a garden 4 developed maleness. After decapitation 2 died and the remaining 2 produced secondary branches bore female flowers. In another case a male plant changed its sex after third topping. It is also a common experience that in some cases change of sex does not take place at all even after repeated topping. The author was also informed that transplantation of seedling caused an increase in the proportion of male plants and that decapitation in these cases gave best results. No definite experiments could be carried out to verify the statement.

Unisexual flowers are really potentially hermaphrodite, and *Carica Papaya* bears flowers shewing all stages of sex transition from hermaphroditism to dioecism and sex reversal in this case has taken place after a violent disturbance in the metabolic equilibrium of the plant.

50. A short note on a case of bud-variation in *Codiaeum variegatum* Willd, and a discussion on its probable origin.

G. P. MAJUMDAR, Calcutta.

Of the four varieties under discussion (dry specimens will be exhibited), and they are permanent varieties, two are broad-leaved lanceolate) and two narrow-leaved (linear), the latter differing from the former only in the shape and size of the lamina the colour pattern of heir leaves being similar. It has been observed :—

(*i*) that the two broad-leaved varieties in their ontogeny occasionally give out buds which develop into their corresponding narrow-leaved varieties, and the new forms are immediately stable in their own .types and when transplanted by cuttings show no tendency to fluctuate towards their parent forms;

(*ii*) that the broad-leaved varieties occasionally give out broad and narrow leaves alternately or in succession on the same branch;

(*iii*) that in all cases only the broad-leaved varieties shew the above variations.

The object of this paper is not to discuss whether the above is a case of hybrid segregation, or vegetative mutation, or bud atavism but is to find out a scientific explanation of the origin of these decided and permanent new forms, which cannot be explained in reference to adaptation and amphimixis, or in other words, in terms of environmental or germinal changes. The author has undertaken microscopic investigation to find out if these sudden variations are due to irregular divisions of the nucleus or to any other changes in the constitution of the nuclear substance of the initial cells during somatic mitosis, and the result thereof will be made known in due time.

51. Petiolar Glands of the Genus Ipomoea.

L. N. Rao, Bangalore.

The presence of extra-floral nectaries has been recorded by many authors for several species of the genus Ipomoea. Some of these Indian species were examined as to the nature of the glands, their anatomy and secretion.

On either sides of the petiole at the point of insertion of the blade are found occurring singly or in groups small glistening depressions from which a sugary liquid oozes out. Each depression is only the external opening of a long narrow duct which communicates with a much branched diverticulum, whose inner surface is lined by a layer of secretary epithelium. There seems to be a tendency for the diverticulum to become more and more branched with the increased area of secretion. Twelve different species of Ipomoea were examined and there seems to be uniformity as regards the structure of the glands, the variation affecting only the number on each side of the petiole, the size and lobation of the glands.

A closely allied genus "Lettsomia" also possesses some members with similar glands, *e.g.*, Lettsomia mysorensis, the anatomy of the glands of which closely resembles that of the genus Ipomoea.

52. Notes on Indian Plant-Teratology.

T. S. Sabnis, Cawnpore.

1. Fission may affect all the parts of the plant and be caused by division of the single growth centre into two or more. In some plants the phenomenon appears to be a case of reversion.

2. Multiple fission may be evolved from binary fission.

3. Proliferation in *Brassica oleracea* L. var. caulorapa appears to be a case of growth correlation.

4. Fasciation affects all parts of the shoot. The phenomenon in *Linum usitatissimum* may be a physiological one or more likely be of genetic origin.

53. A note on the abnormal flowers of *Calotropis procera* R.Br.

A. Sawhney, Lahore.

Some abnormal flowers of *Calotropis procera* were observed by the writer in Lahore in November 1928. These observations were extended later on in Lahore and Sialkot districts and hundreds of flowers were examined. Normally this flower is pentamerous with two carpels and a pentangular stigmatic disc. In many flowers the petals were more than five (six or seven) but the other parts were always normal as regards their number. In other flowers the petals were four in number and they showed a distinct tetramerous structure throughout—the number of sepals, and stamens being four and the stigmatic disc being also 4-angular and not 5-angular. The number of carpels was always two.

54. The systematic value of leaf ash.

S. R. Sengupta, Calcutta.

In early period systematic botany was based exclusively on the study of morphological characters. Gradually anatomical, chemical, and other characters are being utilised in the systematic determination of plants. As pointed out by Prof. Molisch, the leaf ash within certain limits is of great systematic value. The ash may be prepared by heating a small piece of leaf on a platinum foil or directly over flame and then mounting in a drop of aniline oil. Different plant families yield different kinds of ash, a short summary of which is given in the paper.

55. On the teratology of certain Angiosperms V.

T. C. N. Singh, Lucknow.

The author describes abnormalities in the following species of the flowering plants belonging to the families Euphorbiaceæ, Compositæ, Leguminosæ, Moraceæ, Malvaceæ, Oleaceæ, Convolvulaceæ, Palmæ and Caricaceæ :—(1) Occurrence of tricotyledony in *Ricinus communis*, *Zinnia elegans* and *Carica Papaya.* (2) Fasciation of leaf (a homologue of two) : in *Ficus religiosa* and *Zinnia elegans.* (3) Fasciation of nut: in *Areca catechu* (Betel-nut). (4) Fasciation of the peduncular axis in *Jasminum* sp. (5) Fasciation of the stem in Railway creeper, *Ipomaea pulchella.* (6) *Acacia arabica*, tiny dried woody 'coniferous' cone-like bodies were observed to be studded irregularly on the rachis. On close examination it was found that they were formed by the secondary raches being 'telescoped' at a point, thus resulting in a close packing of the pinnules together, simulating a tiny cone.

56. On the pollen grain morphology of the Angiosperms.—II. Boraginaceæ.

T. S. N. Singh, Gohuan.

This paper is a continuation of a paper by my brother Mr. T. C. N. Singh (*Proc. Sixteenth Indian Science Congress*, Madras Meeting, 1929). In the present communication the morphology and structure of the pollen grain of the following species is described and their affinities in the natural scheme of classification discussed :—

(1) *Cordia myxa* Linn.
(2) *Heliotropium ovalifolium* Forsk.
(3) *Heliotropium scabrum* Retz.
(4) *Heliotropium* Sp.
(5) *Trichodesma indicum* Br.
(6) *Cynoglossum denticulatum* A. Dc.

57. Effect of Potassium permanganate on the growth, flowering, and fruiting of *Cicer arietinum* (gram).

T. S. N. SINGH, Coimbatore.

The author has performed series of experiments in which gram seeds were germinated in cultures irrigated (when needed) only with strong solution of Potassium permanganate; and a close study has been made of the changes that took place in the ontogeny of the plant in response to the addition of Potassium permanganate to the soil.

The following results have been obtained in the case of the experimental cultures as compared with the controls which were also irrigated simultaneously with an equal volume of ordinary water :—

(1) Quicker germination.
(2) Much darker green leaves.
(3) Doubly (nearly) longer root-system.
(4) Earliness in flowering and fruiting.

There was, however, no difference in the length of the aerial portions.

58. On the teratology of certain Angiosperms VI.

B. N. SINHA, Nainital.

The author describes abnormalities—all being of the nature of fasciation—of fruits in the following species :—

(1) *Mangifera indica* (Anacardiaceæ), (2) *Punica granatum* (Punicaceæ), (3) *Diospyros tomentosa* (Ebenaceæ), (4) *Solanum melongena* (Solanaceæ), (5) *Musa paradisiaca* var. *sapientum* (Musaceæ). Actual specimens will be exhibited.

59. Ecological survey of sandal areas.

M. SREENIVASAYA *and* S. RANGASWAMI, Bangalore.

With a view to determine the possible ecological differences existing between heavily spiked and healthy sandal areas, an ecological survey of two sets of areas has been conducted. It is believed that, in view of the parasitic nature of sandal, the associated flora influences the susceptibility of sandals to the disease.

Sandal-host ratios, sandal-species ratios, are worked out with a view to determine the availability and suitability of nutrition to sandal. The extent and depth of the root-system of associated host plants in relation to that of sandal has been investigated.

60. Meiosis in *Dodonœa viscosa* L.

R. N. SUTARIA, Ahmedabad.

The resting nucleus of the closely packed polygonal mother-cells exhibits a very granular raticulum, in which is embedded a large central nucleolus. The reticulum contracts from the nuclear membrane and forms a typical synizesis stage. The nucleolus of the synizesis stage does not come in contact with the nuclear membrane.

In later prophase the pachynema threads extend more or less uniformly throughout the nuclear area. The convoluted threads are quite beaded in nature. The spireme breaks up into segments and as the result of continued shortening and thickening, 13 bivalent chromosomes are formed. In later stages of diakinesis the 13 bivalent chromosomes become very compact and are distributed over the periphery of the nucleus. Many polar views of the heterotypic metaphase and late anaphase were seen with 13 small rounded chromosomes arranged more or less in a ring.

The heterotypic and homœotypic divisions occur normally. No resting nuclei are formed during interkinesis. The method of tetrad wall-formation is by furrowing.

61. On *Evolvulus nummularis* L. a new plant immigrant to U.P.

N. K. TIWARY, Benares.

The plant, a native of tropical America, is mentioned neither in Hooker's Flora of British India, nor in Duthie's Flora of the Upper Gangetic Plain. It is therefore believed to be a comparatively recent introduction and to have migrated from the adjoining eastern provinces into Benares. A brief description of the plant including some observations on its habitat is given in this paper.

62. Observations on the artificial germination of pollen grains of *Eugenia jambolana* Lmk.

N. K. TIWARY, Benares.

This paper continues the author's study of this plant and gives an account of the attempts made to induce germination of pollen grains in different strengths of sugar solutions. Certain peculiarities are recorded.

63. Studies on the development of pollen grains of *Eugenia jambolana* Lmk.

N. K. TIWARY, Benares.

In this paper is given an account of the various stages of development of the pollen grains, including certain departures from the normal course of development.

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64. Studies in the pollination and seed formation in Water Hyacinth (*Eichhornia speciosa* L).

S. P. AGHARKAR *and* I. BANERJI, Calcutta.

1. The flowers open early in the morning with the rising of the sun. On cloudy and humid days, however, they open later.
2. The stigma stands high above the anthers in the bud stage. After the opening of the flowers the stigma occupies a position lower than that of the three uppermost anthers. The lower three anthers are situated at the mouth of the corolla tube.
3. Pollen grains examined dry appear to be elliptic in outline. They imbibe water very rapidly and become ovoid. Germination on the stigma takes place generally within an hour after pollination.
4. The style is traversed by three longitudinal canals. The pollen tubes traverse the style through these canals.
5. From the structure of the flower and the relative positions of the stamens and stigma, the flower appears to be insect-pollinated. A bee has been observed to visit the flowers regularly in the morning; it does not appear, however, to take any part in their pollination as it was never noticed to touch the stigmas during its visit.

6. Under natural conditions 35 per cent. of the flowers are pollinated. Bagging experiments show that self-pollination to a very limited extent occurs in this plant.

7. The axis of the inflorescence bends downwards considerably after flowering and brings the flowers under water whenever a free water surface is available. Removal of the flowers or amputation of the inflorescence above the uppermost node has no effect on this bending.

8. Seed formation under natural conditions has not as yet been reported from Bengal. The conditions necessary for the formation of seed are not as yet fully understood. Humidity of the atmosphere and temperature appear to have very great influence. By artificial pollination vialbe seeds have been obtained from flowers of inflorescences not submerged in water during the rainy season. At other times seed formation only took place in those inflorescences which were under water.

65. The problem of water-balance in tropical plants: I. The daily equivalence of transpiratory loss of water under varying intensities of atmospheric conditions.

R. S. INAMDAR *and* B. M. DABRAL, Benares.

From a measurement of the transpiratory loss of water from different potted plants along with evaporation from a free surface of water, it is observed that when a maximum daily value of transpiration is reached, an increase in the intensity of atmospheric conditions has no influence on the transpiratory loss of water. In the natural conditions of habitat in a place like Benares this leads to an equivalence of daily loss of water per unit area of the transpiring surface. Observations are recorded to show that this equivalence of daily loss of water from the plant is brought about as a result of the hourly regulation of the rates of transpiration during the day when the evaporating conditions rise above a certain value.

Investigations under graded intensities of evaporating conditions have shown that transpiration increases directly with an increase in the intensity of evaporating conditions only till a maximum value (which is about $\frac{1}{5}$th the value of the evaporating conditions of the habitat) is reached.

66. The problem of water-balance in tropical plants: II. The water-balance in different stages of growth in the mustard plant.

R. S. INAMDAR, Calcutta.

The water-balance of plants subjected to high intensities of evaporating conditions in the tropical regions is a matter of considerable interest to students of physiology and ecology. It is usually inferred that the rates of transpiration in these plants must be very high and that they must be fluctuating considerably from day to day in response to variations in the evaporating conditions of the atmosphere. This inference, however, has not been found to be true.

Previous observations at Benares on the annual and the perennial plants, which are recorded above, have indicated that a maximum daily value of transpiration is reached at a relatively low intensity of the evaporating conditions of the habitat. There is no reason, therefore, to assume that the rates of transpiration in the tropical plants are abnormally high in response to the prevailing high intensities of evaporating conditions.

The previous observations on mature plants have now been extended to the growing plants of mustard. Daily records of transpiration and evaporation along with those of the atmospheric factors were taken through the entire period of growth commencing from the date ot germination. An analysis of these records shows that the average hourly rates of transpiration per unit area of the transpiring surface for the day period remain constant from day to day for the whole period of growth except for a very short period after germination. The values of evaporation from a free surface of water go on decreasing, however, from October to December when these plants were grown.

This equivalence of daily loss of water is a result of the limit set by root absorption. That this is so is proved by the fact that the ratio $\frac{\text{Dry weight of the root}}{\text{Transpiring leaf area}}$ remains a constant value through the entire period of growth.,

The T/E values go on increasing as the growing season advances towards winter as the daily values of evaporation continue to decrease in general in this season. Following Livingston, it has been customary to use the T/E values obtained from the daily records as a quantitative measure of the intrinsic transpiring power of the plants in different seasons (Cf. Shreve in America). But when the daily values of transpiration remain constant from day to day above a certain value while the values of evaporation go on varying, the T/E values would hardly throw any light quantitatively on the internal factors concerned in the transpiration of plants. This is an aspect of criticism of Relative Transpiration as a measure of the intrinsic transpiring power of plants which has not been emphasised sufficiently and which is to be borne in mind when observations are made on the transpiration of plants in their natural habitats with high intensities of evaporating conditions.

67. The problem of carbohydrate transport in plants. A glucose effect on the permeability of cell membranes to sugar molecules as studied by the intensity of respiration when leaves of *Artocarpus · integrifolia* were injected with varying concentrations of glucose solution.

R. S. Inamdar *and* K. V. Varadpande, Benares.

Though the important role of carbohydrates in the physiology of the cell has been recognised for a very long time, our knowledge concerning the direct penetration of living cells by carbohydrate molecules is only recent. In fact Overton was inclined to deny the permeability of the living membranes to carbohydrate molecules. Hardly anything is known however, about the effect of sugars on variations in the permeability of cell membranes to diffusion of sugar molecules.

This investigation developed as a result of the study of respiratory intensity when the leaves were injected with varying concentrations of glucose solutions. The curves obtained in that connection could not all be explained on the basis of simple relations between concentration and respiratory intensity.

Observations on the rates of respiration were recorded on the control and the experimental leaves simultaneously. From the curves thus obtained the values of the per cent. increase of respiration of the experimental leaves over the controls have been calculated and exploited for purposes of analysis.

The equations for the curves of the hourly march of these values work out in a very simple way in the majority of these curves. They can be expressed as simple logarithmic curves.

For comparing the relationship between the concentration of sugar solutions and the respiratory intensity, the initial values obtained by extrapolating these curves to zero time have been plotted against corresponding concentrations.

The generalised curves thus obtained at different temperatures show an ascending and a descending phase.

The descending phase has been explained in terms of the water factor in the cell.

It is the ascending phase which forms the special feature of this communication. This phase shows the mathematical relationship $R=K.\,Ct^{n}$, *i.e.*, respiration increases relatively more as concentration increases. This is explained in terms of the relatively greater rate of diffusion of sugar molecules as concentration increases. The only way in which this can happen is through variations in the permeability of cell membranes to the diffusion of sugar molecules as the concentration of glucose increases, thus supplying a direct evidence of the effect of glucose on the permeability of cell membranes.

In the equation given above D can be substituted for R, indicating the diffusion of sugar molecules on which the intensity of respiration depends. In that case, K represents the diffusibility factor which would vary at different temperatures and the index n, which is greater than unity, the factor for variations in the permeability of cell membranes. The determination of the precise values of these factors at different temperatures forms the object of subsequent investigations.

68. Studies in growth, senescence and rejuvenescence in plants. The relative distribution of growth and growth materials in the whole plant and its parts at successive stages of development in the long beans.

KRISHNA KUMAR, Benares.

This paper deals primarily with relative growth rate as measured by increase in surface and dry weight production at successive intervals of a week throughout the ontogeny of the Long Beans grown under field conditions. The edaphic factors were such as not to limit growth, and a record of the atmospheric conditions was obtained. The results have been analysed by applying the formulæ of V. H. Blackman and of Inamdar and B. N. Singh.

On an analysis of the data the following generalised conclusions emerge :—

(1) The absolute dry weight curves of the whole plant are of the usual sygmoid type while those of the shoot and the root on computation resolve themselves into strict componential curves. In the early stages of growth. the growth of the root lags behind that of the shoot, probably because of the twining nature of the shoot, which will on that account need early development.

(2) The relative growth rate starts with a high value and shows a characteristic maximum before the initiation of the reproductive organs, thus confirming the observations of Inamdar and B. N. Singh and their co-workers in this laboratory on various plants.

(3) The leaf-area and leaf-weight ratio curves run parallel and each follows the gradient of the growth rate curve only till the period when the maximum is obtained before the initiation of the reproductive organs. Later on no strict proportionality is kept up. This would indicate that the assimilating area is directly responsible for the production of leaf-weight.

With the onset of senescence the area exposed has no correlation with the resultant product, *viz.*, the leaf-weight.

(4) The $\frac{\text{Shoot}}{\text{Root}}$ ratio curve starts with a high value and declines early. A subsequent rise in the mature stage is noticeable, followed by a fall about the sixth week, before the ultimate level phase.

(5) When log-shoot is plotted against log-root it gives a straight line showing a proportionality between the sizes of the two organs. This confirms the view recently put forward by Pearsall, and Inamdar and B. N. Singh. I wish to express my thanks to Dr. B. N. Singh for his interest in this work and for his helpful suggestions and criticisms during the course of this work.

69. The factors concerned in the relative sizes attained by the Shoot and the Root in Herbaceous Plants.

AKSHAIBAR LAL, Benares.

The Problem :—The relative sizes attained by different organs in plants forms a problem entirely by itself among the many problems concerned in the evaluation of growth factors and growth mechanism in plants. The present investigation was undertaken with a view to determine the relative sizes attained by the shoot and root in the fully matured plants growing in different habitats. Selection of habitat being confined to the edaphic conditions such as hard uncultivated soil, cultivated grounds, low lying situation, etc., observation was extended to the herbaceous vegetation of the rainy season at Benares, comprising about 25 species. The attempt was first directed to the enquiry of the physiologically comparable period which after experimentation was fixed at the fruiting stage.

Results :—(1) The $\frac{\text{Shoot}}{\text{Root}}$ ratios are typical for a given habitat and for a given species and are independent of the final sizes attained by the plants.

(2) The ratios are higher in harder soils which are likely to show less moisture-content than in softer cultivated soils or in low lying situations.

(3) The ratios remain constant for a large number of species growing in the same habitat within certain reservation.

(4) The ratios in different species are independent of the final sizes attained by the plants.

General Conclusions :—The approximate constancy of the ratios in different species growing in the same habitat in spite of varying sizes of the plants, indicates clearly that the relative sizes of the shoot and the root are normally determined by internal factors affecting the distribution of growth and growth material in different organs

The variations in the plants growing in different habitats correlated as they are with the moisture conditions of the soil indicate that under unfavourable conditions for root development it is the extent of the absorbing surface developed by the plant which determines the size of the plant and also the $\frac{\text{Shoot}}{\text{Root}}$ ratio. I am indebted to Prof. R. S. Inamdar for his helpful suggestion and criticisms during the course of this work.

70. On the peg of Cucurbita seedlings.

P. MISRA, Cuttack.

It has been observed by F. Darwin that in a normally growing *Cucurbita ovifera* seedling a peg is formed on the physically lower side of the radicle but when grown on a slowly moving klinostat a frill is formed instead of a peg. A number of experiments have been made in this connection and it is further observed that:—

(1) In a germinating seedling of *Cucurbita maxima*, with its radicle vertically downwards (in a position of geotropic equilibrium) in soil, a frill is formed at the base of the radicle.
(2) Even if the radicle be in a position of geotropic equilibrium but illuminated on one side, a peg is formed latterally on the dark-side.
(3) When a side of the radicle is influenced both by gravity and light as in a germinating seedling inclined at an angle of about 25° to the vertical line with the micropyle obliquely downwards towards the dark-side, two pegs are formed—one on the physically lower side due to the influence of gravity and the other on the dark-side due to that of light.
(4) If the tip of the radicle be removed very early, *i.e.*, before it bends, a frill is formed irrespective of the position of the seedling regarding gravity and light.

71. Contribution to the study of the spike disease of Sandal (*Santalum album* Linn). Proteolytic activity in healthy and spiked Sandal.

N. Narasimhamurty, Bangalore.

A study of the ereptic activity of fresh and dried tissues of sandal has been made. A four per cent. salt solution is found to extract the enzyme better than water or glycerine. The time-course reaction of the ereptase extract of the tissues of sandal on peptone has been determined. Ereptase is considerably more active in the diseased tissues than in the healthy ones. The proteolytic degradation indicated by the high amino-nitrogen content of diseased leaf is attributable to the increased ereptic activity accompanying the disease.

72. Contribution to the study of spike disease of Sandal (*Santalum album* Linn). Nitrogen metabolism in healthy and spiked Sandal.

N. Narasimhamurty, Bangalore.

The roots and twigs have about equal amounts of total nitrogen, while about twice the amount exists in the leaves. Total nitrogen in the roots and twigs is lower in the diseased than in the healthy ones in striking contrast to what generally takes place in the leaves. Protein nitrogen which forms the major portion of the total nitrogen is found in lesser quantities in the diseased tissues although in the case of twigs and roots the difference is small. Total water-soluble nitrogen is greater in the healthy twigs and roots than in the diseased samples contrary to what is found in the case of leaves. Total amino-nitrogen, however, is greater in the diseased than in the healthy tissues. The symptoms of proteolytic degradation are not so well marked in the diseased roots and twigs as in the diseased leaves. Nitrate, nitrite, amide, ammonia, humin and basic forms of nitrogen have also been determined.

73. A physiological study of the seedlings of *Eichhornia crassipes*.

P. Parija, Cuttack.

The germination of Eichhornia seeds, which had not been observed and systematically studied in India so far, is described.

The study of the seedlings has yielded the following interesting facts:—

(1) The type of germination observed here is like that of the date and the Borassus. The lower part of the cotyledon grows out carrying the axis of the embryo and the cylindrical tip remains behind as a suctorial organ.
(2) If suitable depth is not reached by the radicle, a hypocotyl is intercalated.
3) Although mature Eichhornia has dimorphic leaves and swollen petioles, the seedlings up to a certain age (which varies according to conditions) have neither of these features.
(4) Although seedlings need free-water in the mud for good growth, submersion under water kills them in their early stages.
(5) After the appearance of traces of swelling of the petiole, submersion does not kill the seedlings. When submerged, they float up breaking away from the root-stock. The seedlings have remarkable power of surviving submersion, in one case a seedling having survived after 11 days' submersion. The quickness with which the seedlings float up depends on the amount of aeremchyma present in them.
(6) The breaking away from the root-stock is a physiological process induced by the buoyancy of the petioles. A transverse meristematic zone is formed in the stem and breaking takes place at this region. No trace of cork is found on surface cells of the wound. Presumably separation is caused by turgor change.
(7) The seedlings float up in the evening between 5 and 8 p.m. exceptions having been observed on cloudy days. It seems that the fall of temperature induces activity in the meristem.

74. Physiological studies on cereals, vegetables, and grasses.

S. A. Rafay, Bangalore.

A detailed study of the growth habits, conditions favourable for growth, and propagation has been made of Ragi, Dolichos, Tomatoes, Lucerne, Elephant-grass and Guinea-grass. The experiments were carried out in pots and plots which received differential treatment of lime, phosphate, and sewage effluent. Periodic dry-measurements of the whole plant and its various parts were taken and the correlation with meteorological observations attempted. Development of different types of roots, amount of lateral branching, degree of penetration, number of nodules, and bacterial counts of the soil were determined. Tillering, flowering, branching, and leaf-area were also noted.

75. A new intermittant Ozone apparatus.

Shri Ranjan, Allahabad.

(1) A new intermittant method of producing Ozone is given. The essential point in this is that the circular piece on the clock of Dr. Blackman's air-current commutator is jacketed with an ebonite ring. Small areas are left open in the ring which is fitted with brass-pieces. When the pin from the long arm of the commutator-clock rides upon this brass-piece, contact is made and when it slips off on the ebonite ring contact is broken.

(2) Ozone has a depressing effect on the rate of respiration.

76. Studies in the respiration of mango-leaves with special reference to Blackman's oxidative anabolism.

SHRI RANJAN *and* N. K. CHATERJEE, Allahabad.

The respiration rates of mango-leaves of various ages and their corresponding Oxygen intakes have been undertaken; but stress on R.Q. has not been given. The actual differences, instead, between CO_2 output and O_2 intake of leaves of varying ages have been shown, and a possible explanation of the high Oxygen intake is given on the lines of Blackman's oxidative anabolism.

77. Oxidases in healthy and spiked tissues of Sandal.

B. N. SASTRI, Bangalore.

A micro-chemical examination of the sandal tissues, for their oxidase and peroxidase content reveals a large number of concentrated areas in the various cells of the diseased tissue, while, in the corresponding healthy tissues the concentration is not high in the mature leaves. In the tender leaves, however, the enzymes are nearly as abundant as in the spiked leaves. The oxidases, peroxidases, and catalases have also been estimated by the usual macro-methods.

78. Chemical study of the buds of spiked and healthy Sandals.

B. N. SASTRI, Bangalore.

Transmission experiments having demonstrated the presence of the infective principle in the buds in high concentration, it was thought that a chemical study of the buds would reveal the nature of the infective principle. Buds derived from the healthy and spiked plants, have been analysed by micro-chemical methods.

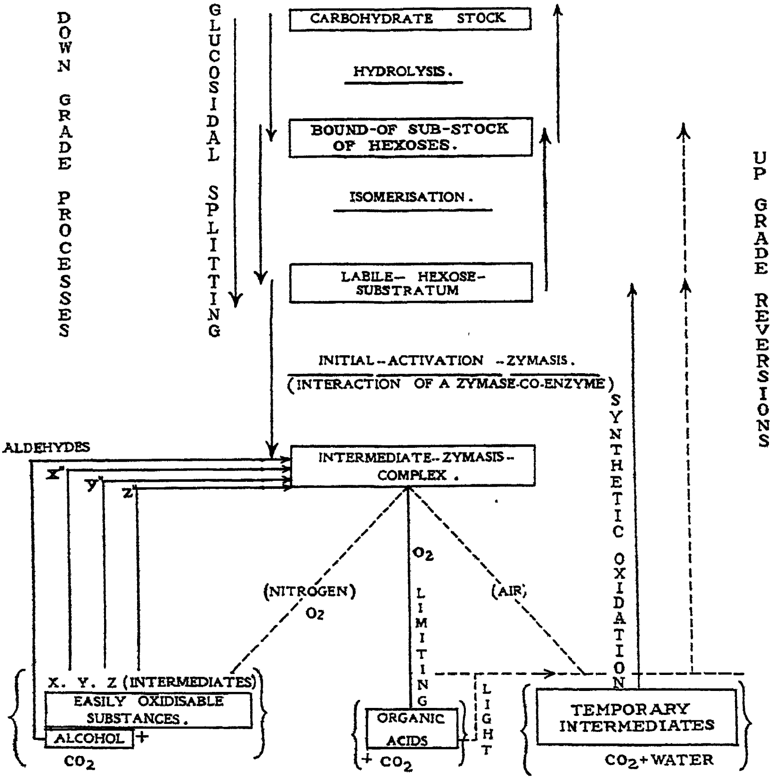
79. The relation between seeds and accompanying microflora, Part I.

T. R. SATHE, Bangalore.

The investigation of the association of specific bacteria on seeds and their influence on germination having failed to give any proof for such specific associations, the work was carried further to determine the rôle if any of the accompanying microflora in the early life of the seedling. Great difficulty is met with in the complete sterilisation of the seed. Total counts and distribution of different organisms was studied with a view to ascertain the nature of organisms. Seeds of ***Ardisia crispa*** are being investigated to study the hereditary symbiolic association with bacteria as found out by Miehe.

80. A proposal of a schema for the dynamic systems involved in the respiration of oranges and knol kohl tubers.

B. N. SINGH. Benares.



81. Studies in the respiration of tropical plants. The mechanism of respiration in fleshy plant organs which offer great organisational resistance to the exchange of gases and store a large stock of carbohydrate reserves: Part I—Analysis of the respiration drift in air and nitrogen and their ratio AN/A at different temperatures, as also the "air-nitrogen" and "nitrogen-air" after-effects in green oranges.

B. N. Singh, Benares.

While studying the effect of temperature on the natural course of respiration in air and nitrogen in massive plant structures like the green oranges, it was discovered, contrary to expectations, that the nitrogen respiration was remarkably higher than the air respiration at all experimental temperatures, illustrating a marked contrast with the previous observations on the leaves of *Artocarpus integrifolia* or *Eugenia jambolana*. This discrepancy cannot be ascribed to a physical lag in the orange material due to organisational resistance, since material differences were reduced to a minimum by drawing samples of green oranges of the same fixed age and size from a population of young and mature oranges growing on the same plant. Nor can it be attributed exclusively to a transition from air to nitrogen, since after such a change was made, the previous values went on continuously rising for a period of as long as 52 hours in certain cases, instead of showing a progressive fall in time. This is attributed to the enormous supply of effective sugars that are present in the oranges, as contrasted with those organs which have very little free sugars.

On a study of the natural drifts and transitions in the course of nitrogen and air respirations, experimented simultaneously in two lots, at temperatures ranging between 15° and 40°C, it is noticed that:—

(1) Apart from the continuously higher rate of nitrogen-respiration, the initial values, in both the types of respiration, follow a temperature sequence towards an increase.

(2) Up to 30°C, both the air and nitrogen respirations depict no decrease in time, for 24 to 52 hours, and the values, instead of showing a decrease (as observed in the Artocarpus or Eugenia leaves), show on the contrary, a progressive rise. This drifting increase in the CO_2 output during the senescent stage of the orange is ascribed to a progressive rate of hydrolysis, to produce greater respirable substrate consequent to an enhanced rate of CO_2 effusion due to a lowering in the organisational resistance of the orange material. At 35°C, an appreciable fall in both the respirations manifests itself in time, clearly indicating that at this critical temperature the active sugars just begin to fall short of the requirements and the supply of the sugars is not controlled by the "*Harbinger-Enzymes*" or the hydrolitic enzymes. At 40°C, a disturbance in the general form of the curves sets in and this is attributed to the "high temperature effect" which seriously affects the respiratory system.

82. Studies in the respiration of tropical plants. The mechanism of respiration in fleshy plant organs which offer great organisational resistance to the exchange of gases, and store a large stock of carbohydrate reserves: Part II—localisation of a shift in the working of the respiratory system with the march of age in the knol kohl tubers.

B. N. Singh, Benares.

In an attempt to bring into purview a more precise conception of the drift of the metabolites involved in the massive plant structures, and its effect on the air and nitrogen respirations, the analytic studies on the respiration of green oranges, were extended to Knol Kohl tubers of varying age and size. With the advance of age, the natural drifts in the carbohydrates, provided a fruitful basis for the study of relative respiratory activity in air and nitrogen in relation with the carbohydrate flux.

It is noted that the size of the tubers has a profound influence on the rate of CO_2 effusion—the larger the size of the tuber, the more is the physical lag and consequently the smaller is the outflow of CO_2, as compared to that emanating from a smaller one of the same age.

The series of experiments conducted on young tubers (1½ months old and of similar size) provide records which amply confirm those obtained for the green oranges in respect of the increased output of anaerobic CO_2, the temperature effect on the two types of respiration and their ratios, as well as the "air-nitrogen" and "nitrogen-air" after-effects. The sugars also abound in the tubers at this stage. The generalisations made for the green oranges apply strictly to these young tubers also.

Further study on the mature tubers (3½ months old) leads to surprisingly divergent results in contradistinction to those obtained for the young tubers but in conformity to those obtained for the Eugenia or the Artocarpus leaves. The anaerobic values of respiration obtained at this stage of development, are actually lower than those of the aerobic, while the whole phase of temperature effect, the "after-effects" and the ratios AN/A, have a different story to tell. The tubers at this stage are rich in the polysaccharides and the non-reducing sugars, and contain very little monosaccharide. Although the general effect of temperature is to raise the relative intensity of both the aerobic and anaerobic respirations, it affects the anaerobic respiration more, indicating thus the formation of some complex metabolites which are not worked back to the condensation products. The time factor appears at a temperature as low as 25°C, indicating a fall in the respiratory sugars, thus giving a clue to the inadequacy of the hydrolysis of the polycaccharides. Further, it is interesting to note that while, with the advance in age, the nitrogen respiration continuously comes down, the aerobic respiration is on an increase till it actually becomes higher than the nitrogen respiration. These interesting results coupled with the ontogenetic drifts in the carbohydrates, suggest a definite clue in the shift of the working of the system as the plant structure gets aged.

On the basis of these results, it is suggested that increase in the nitrogen-respiration is an accompaniment of greater supply of effective sugars and a parallel decrease in the air respiration is due to the working back of part of the intermediate substance preceding the stage of the CO_2 and water production; while, on the other hand, a reversion of the system will result in the decrease of the nitrogen respiration accompanied by a parallel increase in the air respiration, the whole of the latter phase being governed by the rate of hydrolysis of the higher carbohydrate reserves.

83. Studies in growth, senescence, and rejuvenescence in plants. On the intrinsic potentiality of growth: Ontogenetic drifts in the "Respiratory Index" of the meristematic tissues in a population of crop plants. Hydration factor in respiration and growth.

B. N. Singh, Benares.

In the first paper, belonging to this series of researches, it was generalised that the correlated run of many physiological activities, such as the power of cell regeneration, respiration, assimilation, and growth, indicated a connected sequence of metabolic events of the protoplasm during growth, and their striking parallel decline with age, was interpreted as a general expression of a qualitative change in the protoplasm ("metabolic senescence") which affects many physiological activities simultaneously in spite of their diversity, and which, judging by its connection with the hydration factor in the cell, can be ascribed to the colloidal state of the protoplasm. In the present investigation, it is intended to attempt a more realistic analysis of the intrinsic growth potentiality. This advance in realism is based upon bringing into survey the ontogenetic drifts in the respiratory index (at 10° C at atmospheric 02 concentration, when it was presumed that the respirable substrate was not limiting in the respiratory system) and the state of hydration of the meristematic undifferentiated tissues of plants of different habitats and life-duration. Comparative data are also obtained of the relative growth rates and respiration for the entire plants to give the "correlation co-efficients" of growth.

On the basis of the results, the whole population of plants studied may be segregated into representatives of two physiologically distinct groups:—

(A) *Short-lived annuals*, viz., (i) *Pisum sativum*, (ii) *Coriandrum sativum*, (iii) *Carum copticum*, (iv) *Foeniculum vulgare*, (v) *Trigonella Fœnum* *graecum*, (vi) *Hibiscus esculentus*, (vii) *Cicer arietinum*, (viii) *Raphanus sativum*, (ix) *Sinapis* sp. (Mustard), and (B) *Long-lived annuals*, viz., (i) *Dhulia neglectum* (Cotton plant), (ii & iii) two spp. of Beans.

The two classes of plants segregated, have a fundamental difference in the drift of the respiratory index of the meristems. In the short-lived plants, there is a gradual decrease in the values from an early phase of growth (young stage) and the rate of fall becomes more pronounced before the initiation of reproductive organs, while in the long-lived species, the values of respiration maintain more or less a level phase for a considerably long time after germination, at a time when the growth rate and respiration of the *whole* plant are steadily falling, and show a decline only towards the fag end of growth when the reproductive phase intervenes. The difference in the values of the two groups of plants is remarkably correlated with a like difference in the state of hydration in these tissues.

Taking respiratory index, according to Kidd, West and Briggs, and Inamdar, Singh and Pande, as the measure of the metabolic activity of the protoplasm, the following generalisations could be made :—(1) A decline in the katabolism and multiplication of the cells in the growing region will tend to approximate to the gradient of the hydration of the protoplasm (the meristems), (2) The potential longevity of any plant is determined by the relative rates of anabolic and the katabolic activities and the hydration state of the protoplasm in the growing region, and (3) The state of hydration in the growing region appears to be governing both respiration of growth.

The drop in the respiration and the hydration in the tissue, antecedent to the initiation of the reproductive organs, in the two types of plants, and a periodic fall and rise before and after the production of each crop of flowers and bolls in the cotton plant, is attributed to a change in the concentration of the respirable substrate, due to the developing reproductive structures where large quantity of water is experimentally shown to transmigrate even from these growing tips, thus adversely affecting the mechanism of respiration—to cover only in case such a condition does not last for a long time.

84. Studies in the respiration of tropical plants. A search into the nature of the sugar substratæ in respiration; effect of different sugars on the respiration of *Artocarpus integrifolia* leaves.

B. N. Singh, Benares.

Earlier work of the author, both chemical and experimental, carried out in the Benares Laboratories has given many-sided confirmations of the view that the sugars form the respirable substrate. In the present investigation, an analysis is made of the effect of Glucose, Lævulose, and Sucrose solutions on a failing system of respiration in the leaves of *Artocarpus integrifolia* in an attempt to fix the nature of the respiration substrate. On injecting the different sugars (the concentrations of the different sugars to give maximal intensity of respiration being previously determined,) into the leaves at different stages of starvation, it is noticed that, in general, the intensity of respiration goes up, to be followed by a decrease sooner or later, even while the sugar solution is continuously being injected under the conditions of experimentation. This peculiar fall in the values would indicate that either further diffusion of sugar molecules does not take place inside the cell due to an alteration of the cell membrane, or, if at all, the sugar molecules are worked up by an up-grade process to some higher condensation product, or failing which, they are converted after a certain stage, into some intermediate product. It may be that all these processes may be at work. In case the sugars are worked up to higher condensation products, an important conclusion would emerge, *viz.*, that either the injected supply of sugars is not directly made available for respiration, being consequently governed by some enzymic action to supply the exact nature of sugars from the stock, or the external sugar is first used up in raising the concentration of the respirable sugar substratum till a limit ("the *critical concentration*" of the sugar substrate) is reached, and then the excess of the diffusible sugar is probably worked up to "satisfy" the "un-satisfied" carbon links of the "*labile*"group of hexoses. All this goes to emphasise the extreme interconvertibility of the hexoses group of sugars before the actual stage of respiration.

The extra CO_2 produced over that of the control, is neither highest at the "floating stage" of respiration nor at the penultimate stage of senescence (starvation), but somewhere intermediate between the two extremes. This would indicate that in early stages the respirable sugars are not probably limiting respiration, it probably begins to condition at later stages of starvation. The relatively small production of extra CO_2 (or none at all) at a still later stage of senescence, after the administration of the sugar dose, suggests a fundamental change in the mechanism of respiration when some other internal factor or factors begin to fail in their co-ordinated activity.

Out of the different sugars injected, glucose gave the maximal extra-CO_2, although lævulose and sucrose approach glucose in this respect. It is therefore hard to fix, with certainty, as to which is the ultimate respirable substratum, since on reaching the cell centre, they might all be used up in making a stock of bound up sugars which is of a "*labile*" nature.

85. Studies in growth senescence and rejuvenescence in plants. The Influence of the Size and Weight of the Seed on the Growth Potential and the Final yield, as applied to Agriculture.

B. N. SINGH *and* KRISHNA KUMAR, Benares.

The importance of the size of the seeds of crop plants, is one of wide application to agriculture, yet very little critical work has been done to investigate the problem and put the results to agricultural practice.

Seeds of *Raphanus sativus* of pure *Behra-Sindhora gigantum* var. were obtained and carefully sorted out by means of standard sieves into three classes, *viz.*, small, medium, and big. The separation of the above three classes was checked by determining the average volume of seeds in lots of twenty-five, employing the method of displacement of water in a standard graduated 10c.c. measuring jar in each case, till seeds of practically the same size were obtained for each class. The seeds belonging to these three classes were sown in separate lots on ridges under field conditions, such that the nutritional factors were always above the requirements of the plants. A parallel record of the atmospheric conditions was obtained.

Growth was estimated by the increase in fresh and dry weight production in the separate organs as well as the whole plant at successive intervals of a week, and the relative growth-rate calculated. Besides computing the Shoot/Root ratio and the relative sizes of the various organs in relation to the whole plant, an attempt is also made to study the growth potential on the basis of the formula

$$\text{Log } w = n \log t + a,$$

where, w=dry weight, t=days after germination, and a and n=constants.

The results, in general, confirm those already obtained by one of us and another on a different variety of *Raphanus sativus* (cf. *Proc. Sc. Cong.*, 1927) with such deviations as are induced by varietal differences, edaphic and climatic conditions.

It is further noticed that neither the volume of the seeds nor the absolute weights have a decided effect on the production of the plant material or the final yield, but it is the relative density of the seeds which gives the maximum correlation with each. Ordinarily the medium sized seeds give the maximum percentage of germination. The big and small seeds come next in order and there seems to be a competition between them.

It is therefore concluded that for agricultural purposes seeds should be selected on the basis of relative density and not size.

86. Researches on the chemistry and physiology of tropical plants. Analytical studies into the dynamics of carbohydrate-nitrogen flux in the vegetative and the reproductive organs of *Artocarpus integrifolia*.

B. N. SINGH, K. PRASAD, *and* R. N. PANDE, Benares.

A critical study of cell chemistry in the *Artocarpus integrifolia* leaves and reproductive organs gives a basis for the establishment of the assumption that the nature of the food products in the vegetative organ is greatly responsible for the appearance and later development of the fruit. The chemistry of the one seems to be interdependent upon that of the other. Between the emanation of the vegetative and the reproductive primordia here there is an interval of something like a fortnight. Both these activities of the plant appear to start simultaneously together.

The reproductive organs may be said to have four distinct phases in their life-history. The first, or the "young phase", is the "pre-conjugation" and the immediate "post-conjugation" stage; the second, or the "adolescent" one has the march of growth culminating in the third phase, which is antecedent to the full ripe stage, designated as the "partial senescent" phase. This phase, in its turn, merges into the full ripe or the "senescent phase". These four phases are characterised by four different histories of their chemistry.

From the analytical study of the various carbohydrates, and amino-acids in all these stages it is found that the young stage has a high C/N value, in both the vegetative and the reproductive organs; the adolescent one—a continuation of the same proportionality; then follows the stage preceding senescence, showing a high C/N and a low Amino—/Mono-ratio, and last of all comes the full senescent phase, marked out by a high C/N, a low Amino—/Mono-values in the leaves, a low C/N and low Amino—/Mono-values in the fruit.

87. Studies in the respiration of tropical plants. Effect of injecting water, glucose, and phosphates on a failing system of respiration in the *Artocarpus integrifolia* leaves, and its significance on the mechanism of respiration.

B. N. SINGH *and* K. V. VARADPANDE, Benares.

Effect of injecting water, glucose, and phosphates has been studied separately at different stages of respiration in detached leaves of *Artocarpus integrifolia* at different temperatures. It is concluded that in the first instance, insufficiency of water in the respiring cell centre (caused by an increased water loss at higher temperatures, or through long periods of experimentation, or to a failing diffusion from the leaf stalks) brings about a drop in respiration; for, on storing this an increased output of CO_2 is obtained. The fall in the hydration is directly associated with a raising of the concentration of the sugar substrate, till a condition is reached when the machinery of respiration fails entirely, although other reactants of the system be present.

Injection of 2% glucose solution into the respiring leaves, after the appearance of time factor (in both starved and unstarved leaves), shows that there is an increase in the output of CO_2 after this treatment only at low temperatures; while at higher temperatures no such increase has been shown to occur. It is concluded that at higher temperatures, perhaps the machinery responsible for the last phase of respiration is affected adversely somehow—probably due to the accumulation of metabolites which in their turn affect the enzymes responsible for the final respiration. In starved leaves, there is no extra output of CO_2 even on injecting glucose solution at almost all experimental temperatures, indicating thereby that both starvation and high-temperature-effect bring about some dislocation in the machinery. Providing the leaves with glucose or exposing them to light for assimilation have similar effects indicated.

When either the supply of water or glucose fails to enhance the rate of respiration, minute doses of phosphates have a marked effect in the production of extra CO_2 at low and medium temperatures, while at higher temperatures no such recovery of the machinery is possible. It is concluded that it is the enzymes (Zymases ?) that are inactivated as a result of starvation or high—temperature—effect, for although the respirable sugar and water are supplied, no increase in the intensity of respiration manifests. It is also suggested that external supply of sugars is not used up as such. The substrate must be supplied with sugar from the breakdown of the bound or labile group of sugars as an effect of these enzymes. The action of phosphates also suggests that the anaerobic respiration (fermentation) preceding oxidation, even in plants, takes place in two stages with one intermediary of the type of Hexose-phosphate, observed in alcoholic fermenation by Harden and Young.

88. Study on the new type of sterility in Rice.

H. S. SINGH, Benares.

This paper gives an account of the study by the author on the new type of sterility found in the rice plant as well as in that of the after-growth.

So far, the author has come across five types of this phenomenon out of which one is a new discovery by him not so far described by previous workers.

The subject-matter is dealt with as follows :—

Part I. This deals with the definition of sterility.

Part II. This deals with a detailed account of the author's discovery explaining the morphology of the hairs which have replaced the flowers here.

Part III. This deals with cases of sterility, met with in the after-growth and calls attention to certain important features of the flowers as compared to those developed in the proper season. Explanation of these differences is attempted.

89. On the response of the root of gram seedlings to electricity.

T. C. N. SINGH, Lucknow.

Gram seedlings were grown in two different cultures, *viz.*, (1) Pot-culture, and (2) Water-culture. In each case, it was not the atmosphere but the medium—ordinary garden soil in (1) and Sachs' solution in (2)—in which the seedlings were grown, that was subjected to electrification.

As a result of these experiments it was found that the root-system alone was affected and the shoots remained more or less unchanged. The root-system in the control plants was very profuse, the secondary roots being long and slender; while in the electrified plants, it was quite stunted and the lateral (secondary) roots although numerically being as many as in the former case, were stouter, provided with a number of small tertiary rootlets. There was, nevertheless, a complete absence of these on the laterals of control plants. The ratio of the total length of the root of the control to the electrified plant was approximately as 1 : 2.

A short discussion is devoted to explain certain interesting aspects of problems allied to it.

90. Infectivity of various tissues of "spiked" sandal.

M. Sreenivasaya, Bangalore.

Coleman showed the infectious nature of spike disease as early as 1917 and since then the obvious method of control that has generally been advocated is the complete uprooting of sandal, utilisation of any saleable material and the burning of all refuse. In large scale field practice, the operation can never be carried out to perfection and further involves a lot of expenditure.

The infectivity of various tissues of diseased sandal has to be established if a method of rational control is to be laid down for general adoption. In fact, a knowledge as to the distribution of the infective principle in several parts of the plant would be of great assistance in the sylvicultural control of the disease. Different tissues of the diseased sandalwood, bark, leaf and root, and the tissue fluids expressed from them, have been employed to determine their infectivity.

Experiments have established the high infectivity of the leaf tissue, although the fluid from it is not quite so virulent. Patch grafts with the skin have established their infectivity while grafts with the wood tissue and the root-grafts with root skin have been successful in transmitting the disease.

91. Studies in the resistance of sandal to 'spike' disease, Part I.

M. Sreenivasaya, Bangalore.

In the course of our studies on the artificial transmission of spike disease it was found that certain stocks-resisted the external manifestation of the characteristic symptoms of the disease for comparatively long periods. Some in fact have remained immune to the attack in spite of two or three patch grafts which have been carried out with infective material. This observation is one of fundamental importance from the point of view of the practical control of the disease under large scale sylvicultural conditions. It has been found that the size, condition, and species of the associated host plant, the availability of food materials in the soil, the quantity of foliage on the sandal, shade and light conditions, influence the susceptibility of sandals to "spike" disease. Small and inadequate hosts, or hosts which have been badly attacked by other phytophagus insects, lower the resistance of sandal to infection. Foliage on the stock greatly influences the resistance to disease, and a reduction of the foliage partial or total, soon after grafting, renders the sandal highly susceptible to the disease. Sunlight appears to impart resistance to disease. These experiments have been carried out both in the laboratory under controlled conditions and in the field under sylvicultural conditions.

92. Studies in the physiology of sandal, (*Santalum album* Linn.) Part I.

Y. V. Sreenivasa Rao *and* M. Sreenivasaya, Bangalore.

Control cultures of sandal have established (1) that without a host, sandal continues to have a struggling existence, (2) that some host plants are better suited to nourish sandal than others. It has also been found that if sandals are deprived of their host plants either by removal or death of the hosts, the sandal ceases to put on any visible growth; the leaves turn pale and chlorotic in spite of the rich soil that may be provided. But if a host more especially of the leguminous type is re-installed, the sandal in the course of two to three weeks, starts to grow, the pale yellow leaves turn green and puts on a healthy appearance. That the sandal is a root parasite was established by Mr. John Scott (*Jour. Agri. Hort. Soc.*, 1871, ii, 287) but the nature and extent of its parasitism has never been worked out from a biochemical point of view. Experiments have revealed that sandal is dependent upon its host plants largely for its nitrogen and phosphorus requirements. It has also been found that sandal exhibits a preferential affinity to certain types of host plants, with regard to its haustorial attachments.

93. Herbaria and biology.

V. Narayanaswami.

A well equipped and properly staffed herbarium is indispensable for long continued investigations and study of botanico-agricultural problems. If a botanical garden is also attached to it, it then assumes an importance of great scientific value. The indictment passed against herbaria by the Committee ot the British Association—appointed to report on the herbaria and museums of England about the year 1904, that "the dried plant is an inadequate substitute for the living and growing plant and finds its principal use in the authentication of botanical discoveries made in distant lands" is a condemnation born probably of ignorance or prejudice. They still deserve the high place assigned to it by Linneaus in the words 'Herbarium praestat omni Icone, necessurium omni botanico'. It is the critical observations made of plants in their natural habitat and the ability to interpret these observations correctly and record them permanently that gives to the collections a really scientific value and form the basis of future investigations.

There are several herbaria throughout the world, the formation of each has been guided by the particular end in view.

94. Progress of botanical studies in India.

V. Narayanaswami.

The development of the knowledge of Indian plants may be said to fall into 4 definite periods. They are (1) early Sanskrit period, (2) early Portugese and Dutch authors of the XVI and XVII centuries and early part of the XVIII century, commencing from Christobal da Costa, the Portugese Physician, to Dr. Roxburgh, (3) the period from Dr. Roxburgh, and the beginning of the XVIII century, through Wallich, Wight and Griffith, and Thomson and Hooker, (4) the modern period dating from the publication of the Flora of British India by Sir J. D. Hooker. Greater attention was paid to Phanerogams than to the Cryptogams and much less to the internal anatomy or the development of reproductive organs up to the time of Griffith, whose wonderful energy, enthusiasm, and devotion to the study of Botany, found expression in many papers dealing with the minuter study of plants. There have been numerous travellers from foreign countries whose labours have been published in Journals of other countries. In recent years Fossil botany, study of the Cryptogams, and problems of Morphology, Physiology, and Ecology have been touched upon and it is a good sign for the development of Indian Botany in the future.

95. An apparatus to estimate and record intra-molecular respiration in germinating seeds.

C. V. KRISHNA IYENGAR, Bangalore.

(1) During intramolecular respiration gas collected by downward displacement of mercury which is made to flow down in fine drops by some arrangement wherein the capillary tube is used.

(2) The calibre of the capillary tube determines the size of the drop.

(3) Either the weight or the size of the drop is enough to work an electric recording lever which records the number of drops.

(4) Since the size of the drop is constant the rate and the volume of the gas liberated can be directly found without the necessity of calculation.

(5) Water jacket is present to regulate the temperature and maintain the same throughout the experiment.

Section of Geology.

President:—D. PENMAN, D.Sc. (Edin.), B.Sc. HONS. (Lond.), F.R.S.E.

Presidential Address.

GEOLOGICAL EDUCATION IN INDIA.

Introductory.

In the first place I wish to say that while I am not insensible of the honour you have conferred on me by asking me to become President of the Geological Section of the Indian Science Congress this year, it is not without considerable trepidation that I have undertaken the task of preparing this address. My predecessors in this office have all been men of eminence in Geology. I cannot, I am afraid, lay claim to that distinction. I shall therefore confine myself to that aspect of the subject in which perhaps I may claim to have done at least a little, namely, the education of the youth of India in the Science of Geology.

General Education.

The first essential in the training of the geologist is a sound general education. Just as to build a house on unstable foundations shows a lack of forethought and savours of foolishness, so it is unwise to attempt specialisation in any of the Applied Sciences without first of all laying a solid ground-work of broad general education in those branches of knowledge which form the natural avenues to specialised training. In India, the student should not as a rule dream of taking up the study of geology in real earnest until he has obtained at least the Intermediate Certificate in Arts or Science. It matters little which of these he chooses provided that the curriculum contains at least two scientific subjects. On the whole however in the writer's opinion the most useful subjects are English, Mathematics, General Physics, and Chemistry. A good grounding in these four subjects is of the first importance to the aspiring geologist. As English is the usual medium of instruction in scientific subjects, a sound working knowledge of that language is of the very first importance. Proficiency in English is considered so important at the School of which I am in charge that although candidates are required to have passed in that subject in their Intermediate Examination and also to undergo a further test in the Entrance Examination, special tuition in English is given throughout a student's course. In addition, in the class examinations in technical subjects marks are awarded or deducted for good or bad English as the case may be. The geologist must be capable of writing his reports in clear concise every day English and it is, therefore, very important that the student should pay close attention to that subject.

Besides the four subjects mentioned it will prove of great use if the student has some acquaintance with geography and elementary biology. Indeed, if he be ignorant of these subjects it is necessary to obtain instruction in them. At the Indian School of Mines elementary geography is being introduced into the English course and instruction in elementary biology is given as a preliminary to the course in Palæontology.

Choosing Geology as a Profession.

It may be that up to the stage of the Intermediate Examination the student has given little thought to the particular direction in which it may be desirable for him further to prosecute his studies. He may not up to that time have perceived in himself any pronounced proclivity or liking for any particular branch of specialised study. He has often to be guided solely by the advice of others more experienced than himself. There is often in such circumstances a tendency to lean too much upon the advice of persons who may know nothing whatever of the suitability and adaptability of the student to the profession chosen.

There are two main considerations on which a decision of such moment should be made, *viz.*, the suitability of the student in mental ability, general physique, and liking for the work, and secondly the prospects of employment. The latter are often extremely difficult to define, and do not actually emerge until the student has travelled a long distance in his studies. In the writer's opinion the prime consideration is the first mentioned. Many students have drifted or been drifted into spheres of study for which they have proved entirely unsuitable. Occasionally one meets men who would have made good in almost any profession but more often there is a particular groove in which the average student will prove a success whereas in an entirely different line he might be a miserable failure.

The student who enters upon the study of geology will soon find that he requires not only to have the capacity for hard and close study but the physique and enthusiasm to endure long treks in unfrequented parts, in the lonely jungle, up hill and down dale, through, it may be, fever-haunted swamps, and so on. It is true that often perhaps a student must experiment, so to say, in a particular profession before he himself realises whether he is going to like that branch of activity. The writer has said elsewhere that "not everyone who elects to undergo training in a particular profession is suited to the nature of the work involved in the calling chosen and often the evidence of unsuitability does not emerge until much time and money have been spent."

The writer has found in the institution of which he is in charge that even at the end of two years' tuition on technical lines beyond the Intermediate Science or Arts stage many students remain in a state of complete inability to make up their minds as to whether they would prefer to take up, say, the profession of a mining engineer or that of a geologist. A common statement is that the student thinks himself equally suitable for either, and seeks to throw the heaviest burden of the onus of the final decision on the adviser. It is impossible not to feel often times a strong sympathy for the student in his indecision, as more often than not he is concerned mainly with the scope for employment in the two spheres of usefulness. It cannot be too strongly emphasised however that the student should in most cases choose a profession primarily because he likes it and feels that he can make a success of it. If however after having embarked on the study of geology, the student finds the work tedious to him the sooner he gives it up and chooses a more congenial sphere of activity the better. An unenthusiastic geologist is never likely to achieve much and his work will probably grow more and more distasteful to him.

Fascination of Geology.

It would be difficult to specify a more fascinating study than that of geology. There we have a scientific story that leads us back through countless ages to the very beginnings of things. The historian deals with the events of the years and a century to him constitutes a vast store house of happenings, but to the geologist a hundred years is but as the twinkle of an eye. His conception goes back through the long succession of the records of the rocks to the primeval stage of the world's beginnings and for that matter before the world came into being. He sees the life story of creation as an amazing sequence transcending the greatest imaginings of man. He finds romance in stones and the growth and decay of species is more enthralling to him than the rise and fall of empires.

The fascination of the study of geology does not of course find its full expression all at once. But if the student is truly suited to the study his liking for it grows and flourishes on every new and fuller insight into the marvellous revelations of the operations of nature until it becomes to him an all-prevading passion urging him on to his life-work. Such a man must and cannot fail to succeed in his profession. There may be difficulties but with ordinary luck he must eventually surmount them.

There will be always room at the top of any profession for any man who is really and fully suited and equipped for work in the profession he has adopted but the mediocre-fellow whatever his vocation will constantly find it difficult to rise.

Provision for Geological education in India.

Courses in geology are provided at the following institutions in India :—

1. Calcutta University (Presidency College).
2. Madras ,,
3. Bombay ,,
4. Mysore ,,
5. Punjab ,, (Prince of Wales College, Jammu).
6. Benares Hindu University.
7. Indian School of Mines, Dhanbad.

The various courses so far as the geological subjects are concerned are more or less on similar lines. That at Madras University may be cited as an example of the ground covered. The course is divided into five sections namely (I) Physiography (II) Mineralogy and Crystallography (III) Petrology (IV) Structural and Field Geology (V) Stratigraphy and Palæontology. Indian and Economic geology are of course included in the above.

The courses at the Presidency College, Calcutta University, and at Madras University have been in existence longer than the others mentioned. From one point of view the geological department of the Presidency College, Calcutta, is more favourably situated than most. It has the advantages of being close to the offices of the Geological Survey of India and the Indian Museum. Its students therefore have facilities and privileges which are not so easily accessible to geological students elsewhere. The college has also the important advantage of being able to utilise the services of one of the officers of the Geological Survey. It possesses a large and very well-equipped geological laboratory planned by Sir T. H. Holland and now under the able guidance of Professor H. C. Das Gupta. On the other hand, it is not well-situated for work in the field, and students have to travel considerable distances in order to be able to examine geological structures.

In this latter respect the University of Benares is almost equally disadvantageously situated. Excursions to the Vindhyans of Mirzapur and Sassaram are however not difficult.

The University of Bombay is but little better situated in this respect. The students of Bombay and Poona have facilities for studying the Deccan basaltic lavas which are denied Calcutta, Madras, and Benares.

For the study of tectonic geology the Prince of Wales College, Jammu, is more favourably situated. Kashmir is one of the most suitable areas in India for such study. Various economic minerals occur not far from the college and although these are not yet of much commercial importance the outcrops and exposures are of great value for educational purposes.

Mysore University is also fairly well-placed for geological field work. It is within easy reach of the important gold-field of Kolar. There are also many other occurrences of useful minerals in Mysore State as for example asbestos, chromite, iron, limestone, etc.

Within easy reach of Madras there are different kinds of sedimentary, igneous, and metamorphic rock formations and in the Presidency there are important mica, manganese, magnetite, barite, and magnesite deposits.

From the point of view however of proximity to interesting geological formations, tectonic structures and outcrops of mineral deposits no college in India is more admirably situated as the Indian School of Mines, Dhanbad.

All around the School there are excellent outcrops of metamorphics, submetamorphics and gneisses; the Jharia Gondwana coal-field lies within a 5 miles' drive by the college 'bus which is always at the service of the students. In addition, the Rajmahal traps, the mica mines of Kodarma and Domchanch, the Raniganj coal-field, and the valuable iron-ore deposits of Singhbhum are all within easy reach of the School. Until quite recently, it was believed that the tectonic structures of the Jharia coal-field were quite simple. But the work of Dr. Cyril Fox of the Geological Survey of India followed by that of the students of the School of Mines has brought to light tectonic peculiarities from which even an experienced geologist from the Alps may learn something. In addition the following, mineral deposits occur within a radius of 100 miles of the School:—

Amethyst, antimony, apatite, arsenic baryte, pyrite, chromite, coal, copper, fire-clay, gold, iron, kaolin, lead, limestone, manganese, the whole of the mica belt of Bihar, molybdenum, monazite, xenotine, tantalite, columbite, ochre, silver, steatite, tin, uranium, zinc.

The course in Geology at the Indian School of Mines.

One of the objects of the establishment of the Indian School of Mines was the provision of facilities for high-grade training in geology. The courses in Geology consist of a three years' certificate course and a four years' course for the Diploma of Associateship of the School. The minimum qualification for admission is a certificate of having passed the Intermediate Examination in Arts or Science of an Indian University or an examination recognised by the Governor-General in Council as equivalent to the Intermediate Examination. The Intermediate Examination must have included the subjects of English, Mathematics, and either Physics or Chemistry. A competitive entrance examination is held each year in August at several centres throughout India. An applicant for admission to the entrance examination is required amongst other conditions to submit a medical certificate certifying that his eyesight is good, that he is fairly robust, that his constitution is sound and that he has no disease, or bodily or mental infirmity unfitting him now or likely to unfit him in future for active outdoor work as a practical geologist which involves considerable fatigue and exposure.

The first year's course consists of classes in Mathematics, Physics, Chemistry, Mechanics, Surveying, Drawing, Geology, and Practice in the School workshops.

The classes in science subjects are given because it has been found that student from different parts of India have not attained the same standard in the elementary sciences and because further that in most cases these subjects have not been treated in the practical fashion which runs through the whole of the courses at the School.

Drawing has been found to be an important subject as most of the students have had little or no previous acquaintance with that subject. The ability to make neat sketches from plans, models, and actual objects is of great use to the geologist especially in work in the field. The surveying is mainly topographical surveying, a knowledge of which is also necessary to the geologist. Many of the students lack the aptitude for handling tools and instruments and for that reason a certain amount of practice is given in the various workshops attached to the School. There is no doubt but that such work will be found of great value to them in the practical affairs of life.

The School session covers nine months from November to July and during the long vacation—August to October—every student is required to put in at least eight weeks in a mine or in geological field work. Generally in the first vacation students go to a coal mine and combine work in the mine with such preliminary geological field work as the tracing of outcrops, faults, dykes, etc.

In the second year course geological students take classes in Mining, Surveying, Engineering, and Drawing but the chief subject is geology (including Mineralogy, Petrology, Palæontology, Crystallography, etc.). Great importance is attached to geological surveying and mapping. The second long vacation is spent in the field, each student being given an area in the Jharia coal-field, of which he is required to produce a geological map, and to show sections. He is required to make as many sketches of geological sections as possible.

The third year course in Geology consists chiefly of geological subjects with a certain amount of allied classes such as assaying of ores, analysis of coals, ore-dressing, and elementary metalliferous mining. At the end of this year the Examination for the Certificate in Geology is held, and a student is required to pass that examination before he is allowed to proceed to the fourth year's course and the Diploma of Associateship. Field work is continued in the long vacation.

The fourth year course is confined almost exclusively to geological subjects, and special attention is given to microscopic work and rock and mineral analysis.

There are external examiners in the principal subjects of both the Certificate and Diploma examinations.

The aim is to turn out a geologist who will be primarily of use in the field and not merely a man whose training has fitted him solely or primarily for work in the laboratory.

Students are also expected to be able to take photographs in the field and to prepare prints and lantern slides. They are also given instruction in the preparation of rock and mineral microscopic slides, and micro-photography.

A course in Tropical Hygiene is included in the third year's course so that students who have to work for long stretches in the field removed from the amenities of a settled community, as often happens in the career of a geologist, may have guidance as to the best means of keeping fit and clear of disease.

It will be seen that the training is eminently practical throughout and well suited to the requirements of the geologist whose life will have to be spent under tropical conditions.

The School is situated near Dhanbad which is an important railway junction on the E. I. Railway. It is within three miles of the Jharia coal-field, the most important mineral field in British India. It is also within reachable distance of the Ranigunj coal-field of Bengal, and the Giridih coal-field; the mica-bearing areas of Hazaribagh and Kodarma and the iron belt of Singhbhum. The School possesses a motor 'bus and frequent day excursions are paid during the School session to places of geological interest in these areas. These excursions are of great value as they serve the extremely useful purpose of illustrating the lecture work and familiarising the student with the commoner geological features.

In addition, a few more elaborate excursions are carried out each year. In the second year course a week is spent in the mica areas and in the third year a fortnight in the manganese areas of the Central Provinces, and in visiting features of special geological interest in the vicinity of Jubbulpore and Katni. In the final year geological students spend about a month in the Salt Range at Khewra and in the important fossiliferous areas of Cutch.

The main portion of the preliminary training in geological field work is however done in the coal measures of Bihar and Bengal. The student is given an area and a topographical map. He goes into camp for at least two months each year and often longer, and under the guidance of the Professor of Geology obtains a grounding in the general procedure of field observations and records.

The School as will be seen is eminently suited for providing a good general training in geology.

Other special features of the geological training at the School are :– (*a*) the instruction given in elementary mining and ore-dressing, (*b*) the classes in Surveying and Drawing, and (*c*) tutorial classes in French and German.

An elementary acquaintance with coal and metalliferous mining and the methods of dressing ores for the market is of undoubted value to the practical geologist, who may at any time be called upon not only to prove the extent of a mineral deposit but to give at least preliminary advice as to its commercial value and suitability for treatment.

The surveying classes give the student an insight into the exact measurement of land features and their representation on maps. They also enable him to understand and read correctly and easily topographical maps without which ability a geologist will find himself continually handicapped.

The purpose of the classes in French and German is to enable a student to read geological literature in these languages, if necessary, with the aid of a dictionary ; as is well-known French and German scientists are in the very forefront of pioneers of discovery and invention and unless the geologist is capable of keeping himself abreast with what is being published not only in English-speaking countries but also in such important countries as France and (or) Germany he will be apt to remain ignorant of information which may be of importance.

The Geological Department is under the charge of Prof. S. K. Ray, B.Sc., Ph.D., who has had a long experience of geological field work and prospecting.

The importance of work in the field.

It has been indicated that in the training given in the Indian School of Mines, great stress is laid on work in the field. At the very outset, even when he has little acquaintance with geological science the student is taken on frequent excursions to areas of geological interest. In that way he becomes more and more familiar with the various phenomena taught in the class. It may be possible to acquire a considerable knowledge of geological facts from books alone but such knowledge will be superficial and of little practical use unless, side by side with its acquisition, the student has been trained in the powers of observation and deduction by long and varied practice in the field.

Personal observation and study in the field is absolutely essential to a sound training in geology, and any course of geological training which does not give out-of-doors field work an important place in the course is bound to result in additions to the number of ineffectual and inadequate geologists.

Geology is becoming more and more an exact science. The old approximate and often careless methods are giving and must give place to greater accuracy and detail not only in the laboratory but in the field as well. The training given must therefore be calculated throughout to develop habits of precision and accuracy. Above all, honesty and integrity in recording the exact results of observations and extreme care in making and confirming these observations are essential; much may depend upon the records and reports of a geologist and if he turns out to be unreliable, much money, time, and trouble may be wasted, and the geologist will acquire an unenviable reputation for untrustworthiness.

The profession of geology is one to be proud of and one which demands the highest attributes of integrity, keenness of mind, and general culture.

Section of Geology.

Abstracts.

1. The flints and cherts of the Niniyur stage.

L. RAMA RAO *and* C. PRASANNAKUMAR, Bangalore.

The paper describes the flints and cherts associated with rocks of the Niniyur stage in the Trichinopoly Cretaceous area. From a study of a large number of micro sections, with special reference to the important organic structures noticed in them, evidence has been put forward to show that these flints and cherts are *not* original siliceous deposits, but are the result of subsequent silicification of original calcareous deposits. The importance of the recognition of this fact from the point of view of the stratigraphy of the Niniyur stage is indicated.

The chief types of fossil structures described in the paper are illustrated by micro-photographs.

2. X-ray studies of carbonaceous and bituminous substances.

C. MAHADEVAN.

In continuation of the work done on X-ray study of coals (Indian Journal Phys. Volume IV, part 2) some carbonaceous and bituminous substances were examined by the X-ray diffraction methods.

(*a*) Graphitic anthracite gives rings ascribable to carbon and ash; the interspaces between the halos are quite clear testifying to the absence of volatile material. The fairly well-defined rings suggest diffracting particles of coarse dimensions.

(*b*) Fusain, one of the four forms of banded bituminous coals also gives carbon and ash rings. The interspaces between the halos are fairly clear and besides the diffraction pattern shows evidence to structure.

(*c*) Fibrous and non-fibrous peats were next studied. The fibrous peat gives a characteristic fibre pattern; the non-fibrous peat has diffracting centre of colloidal dimensions. From a close correspondence between coal and peat patterns, their compositional similarity and structural dissimilarity are suggested.

(*d*) Elaterite, a hydrocarbon found in association with coal-seams and petroleum deposits gives on examination with the X-ray diffraction methods a number of rings which are all shown to be due to the complex mixture to the higher members of the paraffin series. The X-ray study of the mineral throws definite and interesting light on the composition of the constituent members—a problem which has been left unsolved by purely chemical researches.

3. X-ray study of fossil and natural resins.

C. MAHADEVAN.

About thirty fossils (Indian) and natural resins were studied by the X-ray diffraction methods. In spite of their widely varying chemical composition and age, they all show a close similarity in their intensity maxima. The fossil resins do not show any special tendency towards—crystallisation and they belong to just the two groups into which the natural resins could be classed. From analogy with the results obtained by Sogani, Muller, Shearer, and others on the X-ray diffraction of aliphatic hydrocarbons, it is suggested here, that poly nuclear aromatic compounds are responsible for the patterns obtained.

4. Action of solvents on Indian coal.

N. N. **Chatterjee**, Calcutta.

The detailed analytical methods and procedure to find out the amounts of 'alpha,' 'beta,' and 'gamma' compounds by extracting the coal substance with pyridine and chloroform in the Soxhlet fat extraction apparatus have already been dealt with in a previous paper which is in course of publication. In the present paper, the results of the study of the action of pyridine and chloroform on the Tertiary coals of upper Assam are discussed. The coal samples include (1) Borjan Coal, non-coking variety, Nazira, (2) Borjan coal resinous variety, coking coal, Nazira, and (3) Namdang coal, Makum, strongly coking variety. These coal seams are of the same geological age, *i.e.*, Miocene, and it is supposed that since their deposition in the Miocene, time, they have been subjected to the dynamic metamorphism of the same degree and that they vary from a non-coking to a strongly coking coal. The alpha, beta, and gamma compounds have been determined quantitatively and, from the results obtained, it is shown by the author that the Borjan non-coking coal contains an appreciable quantity—*i.e.*. about 9% of gamma compound which is not in harmony with the Illingworth's theory regarding the relationship between the gamma compound and the coking property.

5. On the occurrence of sulphur in the tertiary coals of Assam.

N. N. **Chatterjee**, Calcutta.

In a previous communication the author has described the different forms in which sulphur occurs in coal and the analytical methods adopted by him for the estimation of sulphur. The present paper is a continuation of the same study and is concerned with the Tertiary coals of upper Assam. The coal samples which were very kindly supplied by Dr. C. S. Fox of the Geological Survey of India include (1) Watching coal, Naga Hills, (2) Borjan coal, non-coking variety, Nazira, (3) Borjan coal, resinous variety, Nazira, (4) Tipong Pani coal, Makum, and (5) Namdang coal, Makum. These are among the high grade coals of Assam and of the same geological age—Miocene. The author has concluded that the vegetable mother substance which was the origin of these coal seams was of great purity. The sulphur content of all these coal samples is very high causing detriment to their value as fuel, and varies in different samples of coal within wide limits. It has also been shown that sulphur present in coal is not due to pyrites alone, but that the major portion of it is of an organic origin. The methods in which the different seams may be best utilised are also discussed.

6. Geology of the area around the centre of the Jharia Gondwana coal basin.

K. L. **Bhola**, Dhanbad.

(Communicated through S. K. Ray, Dhanbad.)

The fact that Gondwana beds were deposited in basin shaped depressions in the older metamorphics was observed by Hughes as early as 1864.

The author during his survey of south-western corner of the Jharia coal-field marked that the outcrop of the coal seams of the Raniganj group turned round along their strike and that along the axial line of the syncline there was a steady but a low dip towards the west. The centre was presumbly situated somewhere towards the west of Jamunia river. A 16″=1 mile map of the area is exhibited to the members.

7. Ball structure in Indian coal.

K. L. **Bhola** *and* M. A. **Majeed**, Dhanbad.

(Communicated through S. K. Ray, Dhanbad.)

The occurrence of ball shaped structure in coal has been observed by many early workers in India and elsewhere, and various theories are put forward from time to time to explain the occurrence. According to some, the balls were fossilised fruits or knots of trees, others thought them to be pieces of coal rounded by the action of water, while still others hold that they were due to the action of heat from the adjacent dykes. But the latest view is that they may be due to a peculiar jointing in coal.

The authors made a special study of the ball structure in the coals of Raniganj and Jharia fields, and have observed that the ordinary jointings of coal pass laterally into curved (rounded) planes. They collected specimens rounded on one side only. From the observations of this nature the authors are of opinion that the jointing is the main cause of ball structure in Indian coal and that this jointing was superinduced by pressure and friction.

8. On a fault pipe and associated spring in Bokaro-Jharia coal-field.

L. P. **Mathur** *and* M. **Ashiq**.

(Communicated through S. K. Ray, Dhanbad.)

1. When making the 1st detailed Geological survey, scale 16″=1 mile, of Bokaro-Jharia coal-field, under the guidance of Prof. S. K. Ray, the writers came across a spring about two furlongs to the west of the Manager's Bungalow, Karmatand Colliery. It is interesting that water comes out of this spring with a certain amount of pressure, characteristic of artesian conditions.

2. The field is much disturbed by numerous faults. Many springs are associated with fault-planes. At this place three faults, with considerable throw, were observed crossing each other. The line of intersection of these three fault-planes evidently forms a pipe-like structure. The authors call it a " fault pipe ". This kind of fault pipe is in no way usual, especially in Jharia coal-field, whose structure is commonly believed to be rather simple. The fault pipe has probably served as an outlet of little resistance to the water percolating through the beds occurring north of the fault pipe, dipping southwards.

3. Detailed Geological map of the area as well as several sections are given.

9. Some Dinosaurian vertebræ.

C. R. **Narayana Rao** *and* L. **Rama Rao**, Bangalore.

Two entire specimens of Dinosaurian vertebræ from the upper Cretaceous rocks near Ariyalur are descrbed in the paper. From a consideration of all the characters in the specimens, one of them (Z1) is considered to belong to the anterior dorsal region of one of the Sauropoda (probably Camarasauridæ) while the other (G 27) is believed to be a vertebra from the cervical region of one the Theropoda (probably Megalosauridæ).

The specimens are exhibited.

10. The limb bones of a Sauropodous Dinosaur.

C. R. NARAYANA RAO *and* L. RAMA RAO, Bangalore.

The paper gives a complete account (accompanied by photographs and sketches taken in the field) of a remarkable massive bony structure discovered lying *in situ* about ¾ mile north-east of Cullmoad. Reasons are put forward in the paper to show that we have, in this structure, the displaced limb bones (Femur, Tibia, and Fibula) of a Sauropodous Dinosaur. The relationship of their present position, as noticed in the field, to that in the living condition is worked out and illustrated by a series of diagrammatic sketches.

The bones are exhibited.

11. A preliminary account of a fossil jaw bone of a Carnivore.

C. R. NARAYANA RAO *and* L. RAMA RAO, Bangalore.

The which are the subject matter of this paper were found, as maxillae, stray fossils between Sainthoray and Otacoil. From a description of the specimen and a complete study of its dentition, its nature, and arrangement, it is considered as probably referable to the genus Hyaena. Comparative studies have been made of this jaw with those of a similar nature described from the Siwalik beds and the distinctness of the South Indian specimen is emphasised. X-ray photographs of the specimen have been taken to determine the number of roots of the pre-molars and molars, and the extent and distribution of the pulp cavities.

The specimen are exhibited and the paper illustrated with photographs.

12. A short note on the occurrence of *Daonella* in the Zansker range.

A. SEN, Calcutta.

The present short note embodies the results of the examination of a few fossils collected by Prof. Kashyap of Lahore from the Central Himalayas. The fossils include 3 species of *Daonella* obtained from the Zansker Range a genus which is believed not to have been recorded from that range.

13. A short note on the Upper Gondwana fossil-plants from Jubbalpore, C.P.

S. DEB, Dhanbad.

(Communicated through S. K. Ray, Dhanbad.)

In this short note, the author has described Alethoptoris Ind. (O. and M.) and Araucarites Mcroptorus (Feistmantel) obtained by Prof. Roy during an excursion of the School of Mines. The first of these has not yet been described from the Jubbalpore stage. While the second, though known from the Jubbalpore stage, has not before this been reported from the Jubbalpore area. Probably the age of the Alethoptoris Ind. (O. and M.) can now be extended from Lias to Middle Dogger.

14. Notes on the crystals of the compounds $R''SO_4 . Am_2BeF_4 . 6H_2O$.

S. L. Biswas, Calcutta.

The Crystals of the isomorphous group of compounds having the composition $R''SO_4 . Am_2 BeF_4 . 6H_2O$. ($R''$=Mg, Mn, Fe, Co, Ni, Cu, Zn, Cd.) have been described. They crystallise in the Monoclinic system showing the form 110, 201, 001, 011, 010, 111, 111, 100, 120, and 130.

15. Petrological studies in the rocks from the Girnar Hills, Kathiawar.

A. G. Jhingram *and* K. K. Mathur, Benares.

This note is a supplement to that on the rocks of Girnar Hill of work carried out in the field and in the laboratories of the Benares Hindu University and published in 1926. A petrographic account of the rocks was also published by M. S. Krishnan the same year. The variations observed within each group have now been studied in detail and modes of rocks have been calculated by Rosiwal's method in thin sections. The minerals of the typical rocks have been separated by means of heavy liquids and chemical analyses of rocks and of the more characteristic minerals have been carried out. The bearing of the new data on the course of differentiation has been studied.

16. The petrography of the igneous intrusions and lava flows of Cutch.

D. C. Jain *and* K. K. Mathur, Benares.

This is a petrographic study of the basic and ultrabasic igneous rocks of Cutch of the Deccan Trap series first noticed by Wynne in 1872. In addition to the examination under the microscope, chemical and geometrical analyses of rocks have been given. The distribution of the principal types in the field has been noted. Their affinities with the igneous rocks of this period in other parts of India have also been studied.

17. The occurrence of spilitic lavas in Singhbhum district, Bihar, and Orissa.

L. A. Narayana Iyer.

The paper deals with a rare occurrence of spilitic lava in South Singhbhum, where considerable volcanic activity prevailed during the "Iron Ore Series" times (Dharwars). Since the rocks were subject to metamorphism, most of them have lost their original identity, and hence are very seldom found.

The spilitic suite of rocks was established by Dewy and Flett, and is characterised by a high percentage of soda, which is due to the action of post volcanic emanations on the original constituents of the rock.

They are rich in soda felspars with all their ferro-magnesian minerals altered to chlorite and magnetite, and vesicular cavities filled with secondary quartz and calcite. But most of them are generally altered, and are represented by cholorite-schists with blebs of calcite.

Rocks of the spilitic suite have not been so far known in India.

18. The geology of the Vizagapatam harbour area.

C. Mahadevan.

Bounded on the southern side by the Simhachelam range and on the northern by the Yerrada hills with the sea as eastern limit and vast salt marshes to the west, the area surrounding Vizagapatam forms an excellent natural harbour. The country rock is garnetiferous gneiss. A charnockitic intrusion accounts for a great deal of the peculiar topography of the place. The paper describes the geology of the harbour area; the origin of the sand dunes of Vizagapatam and of the laterites of the Waltair highlands are incidentally discussed at length.

19. The palæozoic basin of the Shamsh Abari Range, Karnah Dist., Kashmir.

D. N. Wadia, Calcutta.

In course of the geological survey of N-W. Kashmir in the range of mountains dividing the Jhelum drainage from the Kishenganga, a well-defined, open, synclinal basin of Palæozoic sediments has been discovered in the midst of the Gneiss-intruded schists, phyllites and states. The sediments range in age, with several important gaps, from early Cambrian to Triassic. The special interest of the present area lies in the fact that a gradual sequence can be made out from the earliest Purana sediments (Salkhala Series) through a great thickness of unfossiliferous slates (the Dogra Slate of the present author) to a fossilferous group of slates, quartzites, and limestones of Cambro-Silurian age. The last (1) group is 7,000 feet in thickness, containing locally, well-preserved *Trilobites* and Obolaceous *Brachiopods.* It is succeeded by (2) 2,000 ft. of Devonian ? Muth Quartzites; (3) 150 ft. of the local representative of Syringothyris Limestones; (4) 5,000 ft. of Panjal Volcanic Series of Up. Carboniferous lava flows and ash-beds; these in turn are overlaid, in the axis of the syncline by, (5) limestones (200 ft.) belonging to the Zewan Sers, capped by some hundred feet of; (6) Triassic Limestones.

The synclinal axis strikes E-W, the general Himalayan strike of the region being NW-SE; though a considerable amount of compression is present, there is no inversion of the fold.

20. A note on the geology of Danta State, N. Gujrat.

N. L. Sharma, Dhanbad.

(Communicated through S. K. Ray, Dhanbad.)

The oldest rocks of the area are the sedimentaries which consist of Calc-gneisses, crystalline limestone, marble, quartzite, and mica-schists. No definite order has been observed because the quartzite, phyllite, and mica-schists are distributed very locally. The calc-gneisses and crystalline limestones seem to represent the different phases of metamorphism of one type of sedimentary rock. A definite proof for the para-nature of the limestones is afforded by the distinct bedding in the marble.

The sedimentaries are intruded by igneous rocks which came out at different times. The older intrusives consists of schistose quartz-porphyry, granitoid biotite and hornblende gneisses, epidiorites, and doleritic and basaltic veins. The younger intrusives consist of granites, microgranite, and porphyry, and probably part of the epidiorites.

The area (about 350 sqr. miles) has been geologically mapped on 1″= 1 mile topographical sheets

21. Importance of the oceanic salt deposits to geologists.

S. K. Ray, Dhanbad.

In 1861, Bunsem first of all suggested that the etherial magmas are comparable to complex solutions of salts in water. In the ocean the Geologists have one such complex solution.

Döltler's experiment (1907–1908) have conclusively proved that the magma conducts electricity and dissociation of the silicate melts (solution) takes place exactly in a manner similar to the ionised solution of salts.

Very important light is thrown on the constituent of the magmas and on the types of molecular equilibria present therein by the practical application of Gibb's phase rule (1874) on the magmatic solution by Niggli, Bowen, etc., according to Niggli the principal magma components are Kp, Ne, Ts, Gl, N_s, K_s, Co, Fa, Fo, Q, W, O, Mt, and Sp. Molecular equilibria, as are represented by different phases, originate through polymerisation, formation of double salts, addition (silicification), subtraction (entsilicification), etc., of those components. Elements contained in these components take certain characteristic positions in the periodic curve.

Just in a similar manner, the sea water too contains components,—chlorides, sulphates, etc., which, on the drying up of the ocean basin, separate into various mineral phases due to reactions similar to what have been enumerated in case of the magma. Moreover, there seem to exist certain definite mathematical relation between the ionic number of the principal elements of the sea salts.

22. On the geology of the Parasnath Hills, Hazaribagh district, Bihar and Orissa.

S. C. Chatterjee, Patna.

The paper embodies the results of the study of the rocks occurring in the Parasnath Hills. The rocks vary from quartzites and garnetiferous hornblendic quartzites to hornblende-schists and amphibolites. There are gradations from one type to another and the entire series is characterised by the invariable presence of garnet. The field relations and the study of the micro-sections indicate that the rocks are of a para-type, there being only a local occurrence of a diorritic rock on the north-eastern slopes of the hills near Madhuban. This rock is quite unlike any forming the hills. The micro-sections show interesting reactions resulting in the formation of garnet.

23. On the Molim granite, Khasi Hills, Assam.

Hem Ch. Das-Gupta, Calcutta.

The paper contains a description of the rock. The nature of the intrusion of the rock and its age are discussed.

24. Purana rocks of Peninsular India—a study in the petrologic method of correlation.

Hem Ch. Das-Gupta, Calcutta.

According to the prevalent opinion in the matter of the correlation of the Purana rocks of the Indian peninsula, the lower Vindhyan rocks are generally recognised as being equivalent to the Karnuls and thus the

Cuddapahs are considered as being older than the lower Vindhyans and the upper Vindhyans are without any representatives in Southern India. The author is of opinion that the Cuddapah basic lavas and the Malani rhyolites are but two phases of the same volcanic activity and that two distinct divisions may be recognised in the Cuddapahs—a lower and an upper and that the upper Cuddapah stage corresponds to the lower Vindhyan while the Karnuls may be correlated with the upper Vindhyans. The result of the study is summarised in the form of a table.

25. On the geology of Khilchipure State, C. I.

DHARAM PAL, Dhanbad.

The paper states briefly the results of an attempt to survey geologically an area of Deccan trap lavas, 180 square miles in extent and about 110 miles west of Bhopal.

The basal flow rests directly on Vindhyan rocks, each flow being of basaltic composition. Most of the flows show a transition to vesicularity towards base, (zeolitic), while others pass into non-vesicular columnar basalts. Evidences regarding tectonic movements are abundant in the south. More than 60 faults mostly of normal vertical type have been traced.

Instances of Post-Trappean folding, principally of monoclinic nature are abundant in the north, where only a few faults are traceable. Inliers of Upper Vindhyans lie along a belt striking from the north towards west. Evidences of 'Block-movements' are found in the north.

The limestones of the Kandalkheri Valley are associated with chalcedony, and are of both crystalline and amorphous types.

The problem of water prospecting in the area has been investigated by an examination of more than 600 wells.

26. Investigation of the absorption of luminous energy by coal surfaces and its effect on human vision.

S. K. SEN, Dhanbad.

Normal human vision is strained when subjected to the illumination in Coal Mines, where it consists of reflected rays from coal faces, and walls, and passages covered with coal dust. When exposed habitually to such illumination vision generally becomes defective, as is evidenced by the prevalence of Nystagmus amongst Miners.

The present investigation aims at an examination of the constituents of rays reflected by coal, and the percentage of each kind of light absorbed by it together with the probable effects on vision. Results obtained by Spectroscopic and Photometric methods are incorporated.

27. Absorption of light on coal faces and its effect on the miners' eyes.

N. GHOSH *and* S. K. SEN, Dhanbad.

(Communicated through S. K. Ray, Dhanbad.)

The author's investigations are based on the absorption of light on the coal faces and its bad effect on the eyes of the miners due to working in insufficient light—result is colour blindness or night blindness and to find out some remedies. Test of eyes with different intensities of light is carried out by means of a special instrument devised by the authors.

28. Geophysical prospecting methods. The Oetvös Torsion balance and its application in Geological prospecting.

S. K. Ray, Dhanbad.

General remarks about various geophysical prospecting methods. Relation between ordinary geological prospecting and heophysical prospecting.

The Balance; its working formula. Corrections: Geographical effect, Topographical effect, Terrain effect, Cartographical effect, other effects. Horizontal Directing Tendency (H.D.T.) Gradient.

Field work; computing and plotting results. Interpretation of results.

29. On some stone implements from South India.

K. Sripada Rao, Bangalore.

The paper deals with the description of six interesting types of stone implements found in Southern India. Four of these which are evidently designed for hand-grasp were collected from the vicinity of Reddipalle, in the Cuddappah district and these appear to be fashioned out of the cores of rock (bulbs of percussion) left behind after flaking. The other two are new and very interesting types designed for hafting. All these may be assigned to an age decidedly later than the Lower Palaeolithic for reasons adduced.

30. The trap rocks of the Chitaldrug schist belt.

Charles S. Pichamuthu, Bangalore.

This paper presents the petrological characters of the Jogimardi trap, the Bellara trap and the Hornblendic trap of Chitaldrug. The first two are typical diabases with ophitic texture and the presence of relict augites, while the third could be described as an epidiorite with deep tinted hornblendes. Evidence is given to show that these are not surficial lava flows but are intrusions which have been subject to dynamo-metamorphism as a result of which certain spots and patches are formed which have a pseudo-amygdaloidal appearance. The nodules present in some of the rocks are shown to be varioles. The conclusion is arrived at that the Bellara and the Jogimardi traps are identical and possibly of the same age whereas the Hornblendic trap of Chitaldrug is older, not only from the evidence of intrusive relationships but from the fact that they are further advanced in the state of metamorphism.

31. The Geology of the Chandrapura coal-field.

Bhag Singh Lamba, Dhanbad.

Section of Medical and Veterinary Research.

President:—Lt.-Col. R. Knowles, I.M.S.

Presidential Address.

THE EVOLUTION OF MEDICAL PROTOZOOLOGY.

(*Illustrated by Lantern slides.*)

LADIES AND GENTLEMEN,

My first duty is to offer to you a most humble apology. In 1928, the Council of the Indian Science Congress honoured me by asking me to preside over the Medical and Veterinary Research Section in January, 1929, and I accepted. At the time I had applied for leave Home from April to October, 1928, and intended to return to India in ample time for the Congress. Circumstances over which I had no control, however, postponed my leave until the end of July. I was therefore not able to return to India in time for the 1929 Congress. With very great generosity Lt.-Col. R. E. Wright, C.I.E., I.M.S., stepped into the breach at very short notice, and delivered one of the most interesting and important presidential addresses which have ever been delivered to Section.

My second duty is to thank you and the Council of the Congress for the very great honour which you have done me by asking me to preside at the present meeting of the Section ; an honour which I most deeply appreciate, not so much on personal grounds, as on behalf of the Calcutta School of Tropical Medicine and Hygiene. The Indian Science Congress is the one opportunity which scientific workers in India have annually of getting together and comparing notes ; as such it is essentially the most important stimulus to scientific research work in this country.

I have been much exercised in mind as to what subject to choose for this address. For the past nine years my work has centred entirely on problems in medical protozoology, and what has impressed me more and more in the study of this subject is the large and important part which workers in India have played in the development of this new science. I have therefore chosen the evolution of medical protozoology—or, better, of medical protistology—as the subject of my address; for there are many lessons from the past for the worker of the present and the future.

The history of protozoology is almost the history of the evolution of the microscope, since the vast majority of protozoa are so minute that they cannot be studied without a microscope. The father and founder of the science, Antony van Leeuwenhoek (1632–1723) was one of the most marvellous men who ever lived. "This old Hollander," writes Dobell (1922a) "was, in truth, one of the most original men who ever lived. It is impossible to compare him with anybody else, for he belongs to a genus of which he is the type and only species. Your typical scientific genius gets a good education; Leeuwenhoek got practically none. He goes to a university and studies under distinguished professors; not so Leeuwenhoek. He imbibes the traditional knowledge of centuries and then begins to re-arrange and develop it for himself; but all that Leeuwenhoek knows he has learnt himself from Nature, and when he sets to work he relies entirely upon his own native genius. He cannot even read what others have written on the subjects that interest him. He can only talk to Nature, ask her questions in 17th century Dutch, and puzzle out her answers by himself."

Leeuwenhoek was born in 1632 at Delft and came of good Dutch stock. He was probably fairly well-to-do, and married at the age of 22. During most of his long life he held the post of Chamberlain to the Sheriffs of Delft, an office which was probably a sinecure, and devoted his entire time to microscopic studies. He began at the very beginning by learning how to grind and mount lenses. With infinite patience and infinite perseverance he devised every piece of apparatus which he used, repeating his experiments again and again in order to convince himself of their accuracy. He ground all the lenses which he used, and even extracted the silver from its ore in which to mount them. In all he is known to have made and mounted some 400 lenses, some of them having a magnification of 300 or more diameters. With these lenses, Leeuwenhoek commenced to examine every fluid that he could think of, commencing with his own bodily secretions and excretions. For forty years he laboured in complete obscurity, working carefully, incessantly, patiently, and laboriously.

The Royal Society of London had its first origins about 1645, and was officially founded in 1660. Its Secretary wrote to different scientists all over Europe, asking for scientific contributions. One of these letters found its way into the hands of Dr. Reiner de Graaf (whose name is associated with the Graafian follicle), and who was a friend of van Leeuwenhoek. He communicated its contents to Leeuwenhoek. Thereafter, Leeuwenhoek periodically wrote letters to the Royal Society describing his observations. It is in this series of some 200 letters extending over the last fifty years of his life, that Leeuwenhoek described his discoveries. During a large part of that period Great Britain was at war with Holland, but still the letters were smuggled through. He was made a Fellow of the Society in 1680, when 47 years of age, and this appears to have stimulated him to further efforts. This wonderful series of letters written in 17th century Dutch, in a clear scholarly hand, fully illustrated with pen and pencil sketches and drawings, is still extant, being preserved in four large folios in the library of the Royal Society. The letters are to-day as fresh as if they had been written yesterday. In one of the folios attached to a page of the manuscript is a tiny envelope made of tissue paper containing some of his free-hand botanical sections of a plant,—sections now 250 years old, but perfectly fresh and still suitable for mounting to-day.

The immensity of the Leeuwenhoek's observations is almost incredible. He studied the capillary circulation, and the blood corpuscles of different species of animals; also the histology of all manner of plants and animals. He was the first person to see spermatozoa, to see bacteria, to see spirochætes, to see protozoa. He investigated the life history of the louse, the flea, and the ant, and discovered parthenogenesis in the Aphids. He discovered Hydra and its reproduction by budding; he discovered the viviparous reproduction of the vinegar eel; he discovered the Rotifers and their power of surviving desiccation. Animal and vegetable embryology, crystallography, the microscopic study of chemical compounds, were all subjects of his investigations. The letters are not of the character of scientific memoirs, but are familiar conversations, conveying a vivid and delightful impression of the charm and personality of the writer; long, rambling, couched in the colloquial style of his age and country. Yet they created both bacteriology and protozoology, where before there had been neither science. Everywhere he draws a clear differentiation between what he has seen and what he infers; "I have observed" he writes of the former; "I figure to myself" he writes with regard to the latter.

It appears to have been in 1674, according to Dobell, that Leeuwenhoek first saw protozoa. The next year he was observing and studying protozoa in rain water, canal water, infusions of pepper, ginger, and nutmegs, and elsewhere. Naturally the first protozoa which he discovered were free living ciliate or flagllate protozoa, and his descriptions of *Vorticella*, *Stylonychia*, *Bodo*, are stated by Dobell to be so accurate that anyone familiar with these organisms would recognise them from his descriptions. In 1674, he was the first person to see a parasitic protozoon—oöcysts of *Eimeria stiedae*, the coccidium of the rabbit; though he did not know what they were. In 1681, he discovered *Giardia intestinalis* in his own stools, and gave a detailed account of this parasite. In 1683 he discovered *Opalina* of the frog, and also probably *Nyctotherus* of the frog. In 1680 he discovered anaerobic bacteria in pepper infusion, and in the same year, yeasts in beer. In 1681 he discovered the bacteria of the human mouth and intestine—including the spirochætes. He saw and correctly interpreted the cilia and cirri of ciliate protozoa, and the flagella of flagellate protozoa; and even observed and correctly interpreted conjugation amongst the Ciliata.

Leeuwenhoek did not realise the full importance of his discoveries, nor did anyone else in his day. He was content to observe constantly, discover, and describe; contradiction, censure, and even ridicule did not affect him; "It doesn't bother me," he writes. "I know I'm in the right."

And so we may leave this wonderful old Hollander, who for fifty years instructed the scientific world of Europe. He died in 1723 when nearly 91 years of age, still working and observing to the end of a long and ever memorable life.

A little later than van Leeuwenhoek was Louis Joblot (1645–1723), Professor of Mathematics, Geometry, and Perspective at the Royal Academy of Painting and Sculpture in Paris. During his tenure of office his chief attention was turned to the study of optics and microscopy. With the assistance of a scientific instrument maker in Paris he constructed microscopes of various patterns and then used them in the investigation of microscopic animals. His book on microscopes was published in 1718, and the second half of it, illustrated with 12 plates, is devoted to his study "of an innumerable multitude of insects and other animals of divers species." Many of Joblot's "insects" or "fishes" were protozoa, and Dobell (1922 a) considers that this second portion of the volume "is, in fact, the first separate treatise ever written on the 'Infusoria'. It contains the first account, and the earliest published figures of many different protozoa—some of them easily recognisable, but a number not identifiable with any certainty." Joblot used no names for the ciliates which he was studying, but used such terms as 'bagpipes', 'funnels', 'kidneys', 'gluttons', 'pirouette dancers'—'the slipper' for *Paramoecium*, and 'the swan' for *Amphileptus*. His work is chiefly remarkable for the experiments which he conducted to disprove the possibility of spontaneous generation, a matter in which he was precursor of both Spallanzani and Pasteur.

From 1723 to 1786 the field of protozoology lay almost fallow. Many zoologists regarded with doubt and misgiving everything seen with the microscope, though in those days continuous progress was being made in the perfection of that instrument. The great Linnæus (1707–1778) appears to have always been suspicious of the Protozoa—*Chaos infusorium* is the name which he adopts for a whole series of questionable protozoal organisms. The embryonic science of protozoology was regarded rather as a suitable afternoon amusement for children than as a serious subject. Attention was naturally chiefly focussed on the so-called 'Infusoria', since these large free living ciliate protozoa are so readily obtained in vegetable infusions, and are relatively large objects for study. Then in 1786 came Müller's book upon the Infusoria, published posthumously. "It is a remarkable work" writes Dobell; "full of shrewd observations, and showing astonishing insight, but containing of course many mistakes which were inevitable at that period. Many of the protozoa described and sketched by Müller—mostly from examinations made, as were those of Leeuwenhoek, with the aid only of a simple lens—are easily recognizable now by a protozoologist."

Up till about 1840, protozoology remained the perquisite of the micrographers, rather than a special branch of zoology. This period saw in 1838 the publication of Ehrenberg's great classic on the 'Infusoria'. It was a monumental folio volume of 550 pages, accompanied by an atlas of 64 coloured plates; and it summarised his researches, not only in Berlin, but also in Egypt, Arabia, Siberia, and elsewhere. "It contained much that was new" writes Dobell, "and much that true, everything of note that his industrious reading could find in the works of his predecessors, and withal a mass of mistakes, to which he clung tenaciously—in spite of violent contradiction and criticism—to the end of his days". This was followed in 1841 by Dujardin's great work; an octavo volume of some 680 pages with 23 plates; and finally in 1880-1889 by Bütschli's great monograph on the Protozoa. This work marks the end of protozoology as a hobby for microscopists, and the beginning of protozoology as a new science. "It is significant of the vast modern development of protozoology" writes Dobell "that since then no work on a like scale by a single individual has been produced. It is now indeed impossible for any one man even to read all that has been written on the Protozoa, and the more recent workers have had perforce to devote their attention to some particular group of these organisms, or to some special branch of protozoology. To master a detail of the science is now the work of a lifetime. No one man can now claim to be an expert in all protozoology, any more than in all mathematics or all chemistry. The territory already surveyed was so vast that the most he could hope to do was to cultivate his own small holding properly."

From this point onwards we see protozoology studied from two main aspects; firstly as a pure science, an important branch of zoology; secondly, as an applied science, chiefly in medical and veterinary work. The importance of the former method is very great. Structurally and functionally a protozoon is the equivalent, not of a single cell of a metazoal animal, but of a whole metazoal animal itself. Dobell and O'Connor (1921) have well defined the Protozoa as non-cellular animals. Now hitherto biological study has been based almost exclusively upon the study of metazoal, *i.e.*, cellular animals; and all the chief generalizations about such phenomena as birth, growth, development, sex, reproduction, heredity, variation, and death have been based upon such study. To quote Dobell (1922a) " When the more important facts about the Protozoa are firmly established, we shall be able to recast many of our biological theorems in a more satisfactory form. The Protozoa offer us, in other words, a new world of animals for generalization, and a new standpoint from which to survey our old-world zoological knowledge. The discovery of the Protozoa was to zoology what the discovery of America was to geography. But we are still, in protozoology, in the 16th century........As yet we are hardly on the threshold of the new biology, but for those who delight in the destruction of error and the advancement of true learning, the protozoological prospect is already full of hope."

It is with applied protozoology, however, rather than with pure protozoology that the medical man and the veterinary surgeon are concerned, and it is the evolution of this branch of the science that has now become of such fundamental importance in tropical and veterinary medicine.

The first piece of applied protozoology was Pasteur's ever famous study of pébrine. The story is of great historical interest, but I need hardly remind you of it. It is fully described in Mrs. Devonshire's translation of Réné Vallery-Radot's *Life of Pasteur*, and it is one which every scientific student and research worker should read. Pasteur was no protozoologist, but he laid broad and deep the foundations of modern bacteriology, and in doing so he also laid the foundations of medical protozoology. His scientific principles were impeccable, and equalled only by his own practical applications of them. In 1885, the sericultural industry of the world was faced with ruin; the silk fields of France were mortally stricken with pébrine, and even imported seed could not save them, for the infection had spread to Italy, Spain, Austria, Greece, and even China. Eggs, worms, chrysalids, and moths were all infected; the peasant proprietors were in despair. J. B. Dumas appealed to Pasteur to do what he could. Although he replied that he had never handled a silkworm, Pasteur was so distressed by the sufferings of the peasants in the south of France that he immediately took up the problem.

How he solved it may be recalled in a few words. The spores of *Nosema bombycis*, the protozoal parasite that causes pébrine, are very highly refractile. And, although he did not recognise even that he was dealing with a protozoal infection, this gave Pasteur the clue to a prophylactic measure against the disease. You have a room full of cocoons, he wrote. You want to know whether to smother the cocoons and spin off the silk, or to keep them for reproduction. Nothing easier. You hasten the development of about a hundred moths by elevating the temperature; these you crush in a little water and examine under the microscope for the refractile pébrine spores. If they are present, the moths are infected, their seed will be infected, and such seed must not be kept for next year's silkworms. Even if the cultivator be a peasant, he can always bottle a few of the moths in brandy and send them to a testing office or to some experienced person to examine.

It was this discovery that saved the silk industry of the world. The income to the State in the French industry, which had dropped from 130,000,000 francs a year to 8,000,000 francs, was restored; to-day pébrine still lingers to some extent in the silk-fields of France, but whenever it threatens to become severe a rigorous application of the Pasteur method will always stamp it out. In India the pébrine problem is even more difficult than it is in France, since there are successive broods of silkworms in the year instead of only one; but the brilliant work of C. M. Hutchinson (1920) has shown how a more exact application of the Pasteur test may be utilized to stamp out the disease.

If the first great experiment in applied protozoology was carried out by an illustrious Frenchman, Pasteur, the second great pioneer in the same field was a Scotsman, happily to-day still with us, Sir David Bruce. By the end of the 19th century medical protozoology had become intimately linked up with another branch of zoology, *viz.*, entomology; and to-day it is almost essential for every department of medical protozoology to have an entomological worker on its staff.

Bruce's preliminary work on nagana in Zululand was begun in 1894; but proved to be an abortive attempt. In September 1895 he resumed his study of the problem, and in May 1896 he wrote his final report on the disease at Umbobo,—a report subsequently published in London in the next year. It is almost incredible that so great a discovery should have been made in so short a time. Trypanosomes had been known since 1842, if not 1841. Griffith Evans in 1880 had discovered the trypanosome which bears his name in animals infected with surra in the Punjab, and had shown that trypanosomes might be pathogenic. Theobald Smith and Kilborne in America in 1893 had shown that Texas fever of cattle, a disease due to a piroplasma, was transmitted from beast to beast by the agency of ticks. Neither of these two discoveries however is comparable to Bruce's classical work, which laid the foundation of the immense advances which were to follow.

The position when Bruce commenced his work was that there were fly belts in Zululand into which cattle could not be introduced without dying of nagana. The European settlers believed that the disease was caused by the bite of the tsetse, and

Livingstone, the greatest of all African explorers, had been so impressed with the importance of the tsetse that he put a vignette of a tsetse on the title-page of his *Missionary Travels*. The Zulus, however, believed that the disease was "caused by the presence of large game, the wild animals in some way contaminating the grass or drinking water". It was a stroke of genius on Bruce's part to fit these two hypotheses together and get at the truth. Within nine months he had discovered the trypanosome of nagana, which now bears his name—*Trypanosoma brucei;* had shown its presence in the blood of the wild game in the infected areas, and that it was harmless to the wild game, who are habituated to it, but pathogenic to oxen, horses, and other domestic stock introduced into the area of infection. He had discovered the transmission by Glossina, though he considered that such transmission was by direct transference on the proboscis of the fly, and had no suspicion of the cyclical development in the mid-gut and salivary glands of the insect. (It was only later, when Kleine in 1909 showed that fed flies did not become infective until the 18th to the 20th day after the feed on an infected animal, that suspicion of a cyclic development was aroused.)

Bruce's work was fundamental. "He threw a flood of light on many other protozoal diseases" writes Dobell, "and suggested all sorts of possibilities concerning their causation and prevention. He forged new links between zoology and medicine, and between entomology and protozoology . . . . Bruce's work was solid, complete, and demonstrative. By clean experiments and right reasoning he contributed more to science in a few months than hundreds who have followed up his work have since been able to contribute in many years. In work of this sort it is the quality, and not the quantity, that counts. Later researches have but served to enhance the magnitude and the difficulty of the problem which confronted Bruce in 1895; and to find a just parallel to the masterly manner in which he solved it, we must go back to Pasteur. There is, indeed, the same simplicity, the same directness, the same insight, in the work of both these men. Their works are enduring demonstrations of the method of science; they are a delight to read, and illustrate on every page the favourite maxim of Boerhaave; *Simplex sigillum veri.*"

The immediate outcome of Bruce's work was, of course, the Royal Society's Commission on Sleeping Sickness, 1903–1913. India will always be proud that two workers from this country, Lt.-Col. E. D. W. Greig, I.M.S. (retd.), and Brevet-Colonel F. P. Mackie, I.M.S., shared in the work of that Commission The work of the Commission is so well known that here it needs no recapitulation. The Commission was under the directorship of Bruce himself, and its most important discovery was the cyclic development of trypanosomes in tsetse flies, and the relationship between *T. brucei* of wild animals, nagana of domestic animals, and sleeping sickness of man. The position in Africa to-day is still serious enough in all conscience; but, had it not been for Bruce's great discovery, and the work of the Commission, immense tracts of the African continent might to-day have become uninhabited forests in which man could not live.

The rôle of biting insects in the transmission of protozoal diseases, thus established by the work of Smith and Kilborne and that of Bruce, was soon to be further established by the labours of the third of the great pioneers, Sir Ronald Ross, again a Scotsman. I need not here discuss his wonderful discovery of the transmission of bird malaria by Culex mosquitoes. and its applicability to the transmission of human malaria by Anopheles mosquitoes. This—the greatest discovery ever made in tropical medicine—was carried out in India, its final and triumphant issue being reached in Calcutta. There had been much brilliant work done on malaria before Ross' great discovery, whilst its final and complete confirmation by the Italian workers was an essential step on the road of progress. Laveran's great discovery of the malaria parasite (November 6th, 1880) had been confirmed by Richard (1882): the complete schizogony cycle and the relationship of the parasite forms to the temperature chart had been worked out by a host of workers, notably Golgi, Marchifava, Celli, Canalis, Grassi, Feletti, Bignami, Bastianelli, Sanfelice, and Manneberg. But when Ross commenced work on the sporogony cycle in 1895, nothing existed except ingenious guesses as to the truth. Of these perhaps the most important was the paper by Richard Peiffer (1892), who recognised the relationship of the malaria parasites to the coccidia, and predicted for the former an exogenous cycle similar to that of the coccidia, but which, owing to the absence of a resistant stage comparable with the coccidial oöcyst, he thought would be found in the body of some blood sucking insect. The resulting germ, he thought, might find its way into man through the sting of the insects. It is doubtful, however, whether Ross had ever seen this paper, for he does not mention it in his *Memoirs*. Sir Patrick Manson's association with Ross' great discovery we need not dwell on here; nor the details of the great discovery itself. It is all a matter of history, and any medical research worker who has not read Sir Ronald Ross' wonderful *Memoirs* should consider his qualifications for his appointment inadequate.

What one would like to emphasise, however, were the conditions under which Ross worked in those days in India. To-day they are almost incredible. When Ross commenced work on the transmission of malaria nothing was known about the classification of mosquitoes; he could obtain no help, even from the Indian Museum, and it was only by degrees that he realised that he was dealing with three different types; the grey or barred-back (*Culex*), the brindled type (*Aëdes*), and the dappled winged (*Anopheles*). He had to pay the entire cost of his enquiry out of his own pocket. There were no Romanowsky stains in those days, and, to judge from his *Memoirs* almost the whole of his work was carried out by fresh dissections and studying fresh unstained material. Soon after he had started his work, he discovered the process of ex-flagellation in the mosquito; but he had no sooner made this preliminary discovery than he was transferred on special sanitary duty to Bangalore. His views on this transfer, and, the interruption of his work are set forth in the *Memoirs*: "Great is Sanitation—the greatest work, except discovery, that a man can do". And in his pocket-book he wrote the following stanza :—

We cry "God, make us Kings,
Poets or Prophets here"
The scornful answer rings,
"First be My Scavenger".

In April 1897, after a five months' bombardment of Army Headquarters to put him on special duty for malaria investigation, he took two months' leave, and in the rest house at Sigur Ghat discovered for the first time an *Anopheles* adult and realised that its resting attitude on the wall differed from that of the two types which he had been studying previously. It was on August the 20th, 1897, that he first found malarial oöcysts in fed Anopheles at Secunderabad. No sooner had he made this discovery than he was transferred on military duty first to Bombay, then to Kherwara in Rajputana, a place in which it was impossible to obtain material to continue his work. Ross heads the chapter in his *Memoirs* dealing with Kherwara "Punishment", though it is much more likely that his transfers were the result of military routine than of any intention of interfering with his work. Authority always finds it inconvenient to deal with genius; Sir Ronald could never stand either fools or authority patiently, whilst he sought, not to unravel, but to cut through red tape—an impossible procedure. It was during this interval in 1897 that MacCallum discovered the process of fertilisation in *Haemoproteus columbae* of the pigeon, and that the true character of what was termed 'ex-flagellation' became clear.

Finally, however, in March, 1898, Ross received at last the long awaited order, and was instructed to proceed to Calcutta for six months, during which period he was ordered to solve both the problem of malaria transmission and that of kala-azar transmission :—*some* order, when it is realised that the latter problem is still not finally cleared up after twenty-five years of intensive study of it by many workers in India. Even on his arrival in Calcutta, ill-luck still dogged him; for cases of malaria were very difficult to secure, owing to a plague scare; and it was this that drove him to study *Plasmodium praecox* in *Culex* mosquitoes. It was in May 1898 that he sent in his ever memorable *Cultivation of Proteosoma, Labbé, in Grey mosquitoes* to Simla for publication. His views on the fact that it was not issued from the Government Press until October of the same year will be found in his *Memoirs.* In the meantime, some thirty or forty copies had been made by hand and circulated.

If we add to all this the fact that Ross had not received any special protozoological or entomological training, as far as one can judge from his *Memoirs*, that he had to coin a new terminology for the parasite phases that he saw, one becomes even more than ever amazed at the brilliance of his work, his intuition, and his great discovery. In logical sequence Pasteur, Sir David Bruce, and Sir Ronald Ross are the great triumvirate who created medical protozoology.

Ross had predicted on the most solid grounds that the development of the human malarial parasites in Anopheles mosquitoes would be found to be similar to that of *P. praecox* in Culex mosquitoes; but it was the Italian workers who finally demonstrated the actual transmission of human malaria from man to man by Anopheles mosquitoes. From that day to this the actual parts played respectively by Ross and by Grassi in the great discovery have been the subject of an endless and most acrimonious controversy. To the impartial historian of the future, one believes that the claims of both workers will be clear. There are two facts that appear to emerge from a study of the historical record. The first was that the Italian workers were familiar with Ross' work; Grassi in his first publication in October, 1898 (*Policlinico*) refers directly to it, and in his second paper in November, 1898 (*Lincei*) refers to Sir Patrick Manson's account of Ross' work given at the July 1898 annual meeting of the British Medical Association, and states that he had received some of Ross' proteosoma specimens and mosquitoes from Manson. On the other hand, it is abundantly clear from the record that the Italian workers, and above all Grassi—who was both a distinguished entomologist and a distinguished protozoologist—had commenced work at the problem at the same time that Ross did; and that their claim that their work was entirely independent of that by Ross is a true and legitimate one. "Grassi may have been, and probably was influenced and guided to some extent by what he had heard of Ross' discoveries" writes Wenyon (1926, p. 910), "but nevertheless he and his co-workers were the first to obtain the absolutely scientific proof of the specific relation of anopheline mosquitoes to human malaria, and to follow the complete cycle of development of the three human malarial parasites in these mosquitoes, as Ross had done in the case of the parasite of birds". If Grassi had never published anything except his wonderful monograph of 1900, describing in detail the complete life-cycles of the human malarial parasites in anopheline mosquitoes, his claim to fame would still rest secure. As it was, he made many other important contributions both to zoology and to protozoology.

Personally, one would deplore this terrible warfare. Is it not time to bury the hatchet? The controversy has kept the Italian workers in ignorance of the huge volume of anti-malarial work which is going on in India; and the workers in India in ignorance of the work going on in Italy. To both Italy and India alike malaria is the most important problem of all; is it not time for both countries to take stock and make a friendly comparison of notes?

Whatever the true facts of the case, the conditions under which Ross suffered, and the immense difficulties which he had to encounter will never again, one hopes, face the medical research worker in India. To-day, thanks to the re-organisation of the Indian Medical Research Department by the late Sir Pardey Lukis, and to the creation by Sir Leonard Rogers of the Calcutta School of Tropical Medicine conditions are utterly different; the problems are there. there is financial provision for their investigation, the only difficulty is to find men of the right type to investigate them.

If the science of medical protozoology was well established by the beginning of the 20th century, in common with many other branches of medicine and surgery, it received a great stimulus during the Great War. And here we come to further pioneer work, in this case in connection with the intestinal entamœbæ of man.

The study of these organisms goes back to the days of that wonderful pair of workers in India, Timothy Richard Lewis (1841–1886), and David Douglas Cunningham (1843–1914). Lewis was a Welshman, born in 1841, who had a most distinguished career as a student at University College and at Aberdeen. He entered the Army Medical Service in 1868, and was sent out together with D. D. Cunningham to India to investigate and report on cholera. They reached Calcutta in January 1869, and were shortly afterwards attached as "Special Assistants" to the Sanitary Commissioner with the Government of India. Together they studied cholera and other Indian diseases for about a dozen years, publishing during this time a number of important reports on their researches. Lewis' first report (1870) deals with "the microscopic objects found in cholera evacuations," and contained the first account of the organism now known as *Entamœba coli.* In 1882, Lewis was the first to discover the microfilariæ of *Filaria bancrofti*; whilst he also discovered the filaria of the dog, and investigated the relationship of filariasis to chyluria and elephantiasis. His most celebrated memoir, however, was that of 1878 "On the microscopic organisms found in the blood of man and animals, and their relation to disease". This gives a detailed account of the spirochætes of relapsing fever, and the first description of the rat trypanosome which now bears his name, *Trypanosoma lewisi*. He returned to England for good in 1883, on his appointment to the post of Assistant Professor of Pathology at the Army Medical School, Netley, and unfortunately died from pneumonia, apparently contracted as an accidental laboratory infection, in 1886, at the age of only 45.

"Lewis' place in the history of tropical medicine and medical parasitology is not difficult to define," writes Dobell (1922) "He was, like Manson, a pioneer .... If Manson is the 'father of tropical medicine' then assuredly Lewis is at least its godfather; for it will not be forgotten that, in addition to his personal contributions to science, he founded both in India and at Netley, a school and a tradition whose fruits are now visible to all the world in the researches and discoveries of the officers of the Indian Medical Service and the Royal Army Medical Corps. .... Lewis was an honest man and an honest worker. .... He was an indefatigable worker, and as conscientious and careful in the observation of facts, as he was cautious and clear in their interpretation." And Dobell goes on to mention that shortly before his death Lewis had been recommended by the Council of the Royal Society for election to the Fellowship—an honour which he did not live to see consummated.

Concerning the career of D. D. Cunningham (1843–1914) I have been able to gather only very few particulars, and those chiefly from an obituary notice by Sir David Prain. He was a son of the Free Kirk of Scotland, and educated at Edinburgh. He entered the Indian Medical Service in 1868, went on a tour with Lewis on the continent to study mycological methods, and arrived in India with Lewis in January, 1869. Most of his service was spent in Calcutta as Professor of Physiology at the Calcutta Medical College. Although most of his publications deal with the cholera enquiry, he was essentially a worker in cryptogamic botany, and gave much valuable advice to Government with regard to cinchona plantation. One of the things for which he will always remain famous was the establishment of the small laboratory in the Calcutta Zoological Gardens, in which so many famous men have worked, but which—alas!—is to-day deserted and neglected,—a most valuable field for study lost. He was also especially associated with the Indian Museum and the Asiatic Society of Bengal.

Cunningham further investigated the amœbæ which Lewis had found in cholera stools, and gave a detailed description of both the motile and the encysted phase. Dobell (1919 p. 72) quotes exhaustively from this account, and concludes that "nobody who reads Cunningham's account, and studies his pictures can fail, if he knows this organism, to recognise in them the commonest of the intestinal amœbæ of man—*Entamœba coli.*" Cunningham also gave accounts of both *Trichomonas hominis* and *Chilomastix mesnili*, but neither of them are as accurate as his account of *E. coli.* Still later he was the first person to see *Leishmania tropica*, as the colour plate illustrating his memoir, now in the museum of the Calcutta School of Tropical Medicine, clearly shows. The staining methods of those days were crude, however, and he was not able to correctly interpret the structure or morphology of these organisms, and it remained for Leishman at Netley in 1903 and independently Donovan in Madras in the same year to give the first recognisable account of the leishmania parasites. With regard to his work on intestinal organisms unfortunately Cunningham later was led astray by the finding of flagellate protozoa together with entamœbæ in the same stools into ascribing all the forms which he had accurately observed and described into the life-cycle of a single suppositious organism, which he named *Protomyxomyces coprinarius*, and regarded as sort of Mycetozoon.

"Cunningham was an able and sound scientist" writes Balfour (1925), "most accurate, honest, and careful, but with a critical faculty perhaps unduly developed .... He will always remain not only one of the leading names in the annals of the Indian Medical Service, but a pioneer to whom great credit is due for his painstaking researches." The climate of Calcutta however ruined his health and he retired as an invalid to Torquay in 1898, to devote himself to his garden, his books, and his canine friends.

Lewis and Cunningham did not name the amœbæ which they studied in Calcutta, but simply used the term 'amoebae'. They were right in assuming that this species was in no way pathogenic. *Entamœba histolytica* was first discovered by Lösch in 1875 in Petrograd, and he rightly regarded this species as pathogenic to man. Lösch also used no specific name for his organism; he uses the term 'Amoeba coli', non-italicised, and even then with some hesitation.

The subsequent history of the study of the entamœbae of man has been dealt with in full detail by Dobell (1919 p. 27). It is a tale of disaster, of chaos piled on chaos, and of confusion becoming worse confounded. Distinguished names occur in the record, but not much distinguished work. By 1918 *E. coli* had been described under 22 different synonymns, and *E. histolytica* under 33, and hardly a month passed without the discovery of some 'new amœba of man'. Then came the Great War. The belief by that time was universal that almost all the dysentery of the tropics was of amœbic origin, and

British and Indian troops alike fighting on tropical war fronts were drenched with emetine, which was given in drastic and most dangerous doses. How many hundreds or even thousands were crippled by this 'treatment' one will never know, but one does know of army officers whose cardiac mechanism was pemanently damaged by it, and who had to be invalided in consequence.

The first attempt to get matters right was made by Walker, even before the war, in 1911. Musgrave and Clegg (1904, 1906) had upheld the quaint thesis that "all amœbae are or may become pathogenic ...... The whole of the surface flora of the Philippine Islands carries a large number of these parasites. Some of them, at least, belong to the class which produces disease in human beings". Walker (1911) clearly differentiated the free-living amœbæ of the Manila water supply from the entozoic entamœbæ, showed that *E. coli* and *E. histolytica* were different species, and finally in 1913 in conjunction with Sellards experimentally proved the mode of transmission of entamœbic infections.

The war, however, made a careful study of the subject imperative, since dysentery is such an important war disease. In 1915, large numbers of troops from the eastern war areas began to arrive in Great Britain : dysentery was very rife on the Gallipoli and Egyptian fronts, and protozoological examination of an enormous number of stools was called for. This work was begun by Dr. C. M. Wenyon, but was taken over at the end of 1915 by Mr. Clifford Dobell, M.A., F.R.S., now Protistologist to the Medical Research Council of Great Britain. Dr. Wenyon was transferred to Alexandria, where in conjunction with Dr. F. W. O'Connor, he commenced similar investigations on troops from the Gallipoli, Salonika, and Palestine fronts.

The results of these researches were, and are to-day, of fundamental importance. In 1917, there was published Wenyon and O'Connor's *Human Intestinal Protozoa in the Near East*, a most valuable, though perhaps slightly incomplete, work. Then in 1919 came Dobell's great work, *The Amœbae living in Man.*

The Amœbae living in Man is characteristic of all Mr. Dobell's work. It is no hurried or sketchy compilation, but the result of intense and extensive personal work of the very highest order, of mature thought and reflection. Its contents cannot be assimilated at a single reading; it is a book to study again and again and again; also it is full of most valuable practical laboratory instructions, and based upon very extensive personal investigation. It was followed in 1921 by a second, excellent work, Dobell and O'Connor's *The Intestinal Protozoa of Man.* To the student in India who wishes to familiarise himself with the intestinal protozoa of man the best advice that one can give is to study these two books again and again, and to constantly examine the stools of sweepers, who, from the nature of their duties, sooner or later pick up most of the infections concerned.

As will be seen, our knowledge of the blood-inhabiting protozoa of man had been built up by degrees; whilst the war work cleared up the confusion with regard to the intestinal protozoa of man. It is probable that by now all, or almost all, of the human protozoal parasites are known. It is time to mention the question of literature and text-books. Doflein's great work, *Lehrbuch der Protozenkunde*, was first published in 1901, but was available only to students who could read German. It was followed by Minchin's *Introduction to the Study of the Protozoa* in 1912. Edward Alfred Minchin (1866–1915) may, indeed, be said to have been the founder of the British school of protozoology. Essentially a cytologist and zoologist, Minchin was a master of technique. For many years he was Assistant to Sir Edwin Ray Lankester and Demonstrator in Comparative Anatomy at Oxford, during which period he published brilliant and valuable work on the sponges. In 1905, he joined the Sleeping Sickness Commission in Uganda, where his knowledge of insect anatomy and dissection were invaluable to the Commission, and where, with Gray and Tulloch he discovered the occurrence of wild trypanosomes (*T. grayi*) in the tsetse, which the recent work of Hoare (1929) has now shown to be an evolutionary stage of *T. kochi* of the crocodile. In 1906, he was appointed to the then newly-established Professorship of Protozoology in the University of London, tenable at the Lister Institute, from which Institute he published a series of ever memorable papers, dealing chiefly with the life history of the trypanosomes, and the inter-relationships of the Hæmosporidiidea. His *Introduction to the Study of the Protozoa*, however, was his most notable contribution to science. For many years it was the constant and familiar companion of those of us who were trying to teach ourselves a little protozoology. Finally, in 1926, came Wenyon's sumptuous *Protozoology, a manual for medical men, veterinarians, and zoologists*, in two volumes. It has been followed by several smaller works. In 1923, there was no text-book of medical protozoology in the English language; to-day perhaps there are too many. That alone shows how rapid has been the progress of the science.

I have attempted, gentlemen, to sketch as briefly as I could, the amazing and rapid growth of medical protozoology, almost the newest and latest of the medical sciences to evolve. There are dozens of other names which I should have mentioned, other discoveries of importance, whilst I am incompetent to touch upon the allied development of the science of pure protozoology itself. In connection with India, there are two other names, however, which I cannot pass over. The first is that of Vandyke Carter (1831–1897), who discovered the Indian strain of the spirochæte of relapsing fever, and proved its infectiousness by experiments upon himself: he also described the organism of rat-bite fever in the rat, and correctly concluded that this organism is a Spirillum and not a spirochæte. The second is that of Sir Leonard Rogers, who, when he succeeded in 1904 in cultivating *Leishmania donovani in vitro*, was the first worker to cultivate a protozoal parasite on artificial media. That discovery was the precursor of much work of very great value; to-day, in my own department, for example, the routine diagnosis of kala-azar, of malaria, of infections with intestinal entamœbæ and flagellate protozoa, is carried out very largely by cultural methods.

Let me, however, gentlemen, draw my moral and conclude my tale. Medical protozoology has been very largely built up by medical men with no zoological training, and it has suffered in consequence. The 'student mind' is not given to everyone, whilst the critical spirit is more rare, and the untrained and ill-informed tyro does not hesitate to rush into print. Errors and dogmas have been laid down, which it has taken many years of careful work and patient observation to correct.

Yet the importance of medical protozoology in the practice of medicine in the tropics is very great. Now, what is the position with regard to the medical curricula in the different universities of India? In my opinion the syllabuses in pathology in India everywhere pay too much attention to morbid histology, and far too little to parasitology. The practising physician in India does not need to be able to diagnose an osteo-chondro-sarcoma microscopically; he can send a portion of the growth to a laboratory expert for diagnosis. But if he has not been trained in microscopical technique, if he cannot identify a malaria parasite, or differentiate between the different entamœbæ living in the intestinal tract of man, his work will be shoddy and sterile. He may commence his professional career as a physician, *i.e.*, one who does his best to diagnose the disease from which his patient is suffering, and to treat it appropriately; no matter how much money he makes, nor how many honours descend upon him, he will end it as a quack, content merely to treat different *symptoms* as they appear, and to leave the issue to the healing hand of Nature.

"As a profession" writes Dobell, "protozoology still hardly exists......But the science has now become so vast, from the amassing myriads of complicated details, that it can no longer be regarded as an occupation for anyone but a highly trained specialist. The amateur toying with his microscope, the ordinary zoologist or physician working in occasional vacation or leisure hours snatched from practice, can no longer be expected to make any solid contributions to protozoology. In future all great advances in knowledge must come from those who are bred up as protozoologists ......Unless the protozoologists can build solidly, and not too slowly, they will lose their advantages. Unfortunately no adequate provision has yet been made for the training of workers in protozoology. At present there are in Britain and elsewhere few first-rate professional protozoologists, and few competent teachers, but a large number of day labourers and dabblers from other sciences. Protozoologists are still mainly recruited from other professions. The remedy for this state of affairs will be found only when protozoology is recognised as a separate science, an occupation for specialists and not for smatterers; and when encouragement is given to its development by the founding of professorships in the subject—or similar appointments—in the larger universities. These professorships must be primarily for research, and secondarily for teaching purposes. The professor must have ample time and funds for teaching himself, and for carrying out his own researches. If he is sufficiently gifted to do both these things, he will be able at the same time to teach his science to others who will follow in his footsteps. But the time has now gone by when the junior demonstrator in zoology, or the lecturer in general parasitolgy in the medical schools can expect to 'take up' protozoology for a term or two and thereby profit science or himself."

I do not suggest that medical protozoology should be added as a separate subject to the already overloaded medical curriculum in the Indian universities, but the time has come when the important protozoological discoveries of the present and of the past should be incorporated in the general practice and teaching of medicine in India. The medical student should be taught more parasitology, and, perhaps, less morbid histology.

One further remark, and I have done. The day of the great pioneers is over; the field has been so well reaped that the first harvest has been garnered. But there remain for solution an immense number of more detailed problems. These call for team work; the medical protozoologist can no longer enter his laboratory and lock its door. He may require at any moment the co-operation of the entomologist, the bacteriologist, the chemist, and—above all—the biochemist, —the last named species of individual being one whom all directors of major laboratories dream about, but rarely or never succeed in obtaining. Where are the workers in this subject coming from in India, unless we envisage the problems ahead and train men for these duties ? We, in India, have a tradition to uphold. Let us attempt to live up to it.

REFERENCES.

Balfour, A. B. (1925) .. Some British and American pioneers in tropical medicine and hygiene. *Trans. Roy. Soc. Trop. Med. and Hyg.*, XIX, 189.

Bruce, D. (1897) .. .. *Further report on the tsetse fly disease or nagana in Zululand.* Umbobo, May 29th 1896, London.

Carter, H. V. (1887) .. Note on occurrence of a minute blood spirillum in an Indian rat. *Sci. Mem. Med. Off. Army India.*, Part III, p. 45.

Cunningham, D. D. (1871) .. A report on cholera (From *Ann. Rept. San. Commr. with Govt. India., App.* B., p. 141.)

Cunningham, D. D. (1885) .. On the presence of peculiar parasitic organisms in the tissues of a specimen of Delhi boil. *Sci. Mem. Med. Off. Army. India.*, I, 21.

Dobell, C. (1919) .. .. *The Amoebæ living in Man*, London.

Dobell, C. (1922) .. .. T. R. Lewis, 1841–1886. *Parasitology*, XIV, 413.

Dobell, C. (1922*a*) .. Protozoology. *Encycl. Britann.* 12th Edit., XXXII, 186.

Dobell, C. and O'Connor, F. W. (1921) .. .. *The Intestinal Protozoa of Man*, London.

Doflein, F. (1901) .. *Lehrbuch der Protozoenkunde*, Jena.

Donovan, C. (1903) .. The aetiology of one of the heterogeneous fevers in India. *British Med. Journ.*, II, 1401.

Evans, G. (1880) .. .. Report on "Surra" disease in the Dera Ismail Khan district. *Punjab Govt. Milit. Dept.*, No. 493, 4467.

Grassi, B. (1898) .. Rapporti tra la malaria *e* peculiari Insetti. *Policlinico.* 1st Oct. Also *Rendic. R. Accad. dei Linceet.*, VII, 163.

Grassi, B. (1898*a*) .. La malaria propagata per mezzo di peculiari insetti. *Rendic, R. Accad. dei Lincei.* VII, 234.

Grassi, B. (1900) .. .. *Studi di uno zoologo sulla malaria.* Rome. (German Version. *Die Malaria.* Jena. 1901.)

Hoare, C. A. (1929) .. Studies on *Trypanosoma grayi.* 2. Experimental transmission to the crocodile. *Trans. Roy. Soc. Trop. Med. and Hyg.*, XXIII, 39.

Hutchinson, C. M. (1920) .. Pébrine in India. *Mem. Dept. Agricult. India. Bacteriol. Series* I, No. 6, Nov., 1920.

Kleine, F. K. (1909) .. Weitere wisseuschaftliche Beobachtungen uber die Entwicklung von Trypanosomen in Glossinen. *Deutsch Med. Wochenschr.* XXXV, 924.

Leishman, W. B. (1903) .. On the possibility of the occurrence of trypanosomiasis in India. *British Med. Journ.* I, 1252, II, 1376.

Lewis, T. R. (1870) .. A report on the microscopic objects found in cholera evacuations. Appendix to *Ann. Rept. San. Commr. Govt. India.* Calcutta, 1869, No. VI, p. 126.

Lewis, T. R. (1878) .. The microscopic organisms found in the blood of man and animals, and their relation to disease. *Ann. Rept. San. Commr. Govt. India,* 1877, No. XIV, p. 157.

Lösch, F. (1875) .. .. Massenhafte Entwickelung von Amoben im Dickarm *Arch. f. path. Anat.* LXV, 196.

Minchin, E. A. (1912) .. *An Introduction to the Study of the Protozoa,* London.

Minchin, E. A., Gray, A. C. H., and Tulloch, F. M. G. (1906).. *Glossina palpalis* in its relation to *Trypanosoma gambiense* and other trypanosomes (Preliminary report). *Proc. Roy. Soc. B.,* LXXVIII, 242.

Musgrave, W. E. and Clegg, M. T. (1904) .. .. Amebas: their cultivation and aetiologic significance. *Dept. Interior, Bureau Govt. Lab. Biol. Lab. Bull.,* No. 18, Part I, 1, Manila.

Musgrave, W. E. and Clegg, M. T. (1906) .. .. The cultivation and pathogenesis of amoebae. *Philippine. Journ. Sci.,* I, 909.

Pfeiffer, R. (1892) .. *Beitrage zur Protozoen forschung. I Die Coccidien Krankbeit der Kaninchen.* Berlin.

Prain, D. (1917) .. David Douglas Cunningham, 1843–1914. *Proc. Roy. Soc. B.,* LXXXIX, p. XV.

Richard, J. (1882) .. Sur le parasite de la malaria. *Naturalists,* II. 57.

Rogers, L. (1904) .. Preliminary note on the development of *Trypanosoma* in cultures of the Cunningham-Leishman-Donovan bodies of cachexial fever and kala-azar. *Lancet,* II, 215.

Ross, R. (1898) .. Report on the cultivation of *Proteosoma, Labbé, in grey mosquitoes,* Calcutta (Dated May 21st 1898, issued October, 1898; reprinted in *Indian Med. Gaz.,* XXXIII, 401, 448.).

Ross, R. (1923) .. *Memoirs.* London.

Smith, T. and Kilborne, F. E. (1893) .. .. Investigations into the nature, causation, and prevention of Texas or Southern cattle fever. *U.S. Dept. Agric. Bur. Anim. Indust. Bull.* I, 177.

Vallery-Radot, R. (1923) .. *The Life of Pasteur.* Translated from the French by Mrs. R. L. Devonshire. London.

Walker, E. L. (1911) ..	A comparative study of the amœbæ in the Manila water supply, in the intestinal tract of healthy persons, and in amœbic dysentery. *Philppine Jour. Sci.* (*B*), VI, 259.
Walker, E. L. and Sellards, A. W. (1913)	Experimental entamœbic dysentery. *Philippine Journ. Sci.* (*B*), VIII. 253.
Wenyon, C. M. (1926) ..	*Protozoology, a manual for medical men, veterinarians, and zoologists,* London.
Wenyon, C. M. and O'Connor, F. W. (1917)	*Human intestinal Protozoa in the Near East,* London.

Section of Medical and Veterinary Research.

Abstracts.

FILARIASIS AND HELMINTHOLOGY.

1. A Clinical Study of Filariasis.

DOUGLAS N. FORMAN, Allahabad

A group of filariasis patients, all giving a positive night blood concentration test, was exhibited. Emphasis is laid on the fact that filariasis is a much commoner condition in dispensary and private practice than has been supposed. In the Jumna Dispensaries, 12.5 per cent. of those examined—a total of about 3,000 tests—have revealed the presence of embryos in the night-blood.

Headache, general aches and pains, irregular fever—simulating typhoid, dengue or relapsing malaria,—feverishness, dysmenorrhœa, hæmoptysis, hæmaturia, nervousness, 'fits', abdominal and substernal pain, dysentery, and diarrhœa may, in any given case, be attributable to the presence of large numbers of filarial embryos in the blood stream, or to local lesions produced by the adult worms. Unduly sharp reactions to injections of such substances as neosalvarsan and ethyl ester hydnocarpus are especially suggestive of filarial infection. So-called malarial fever which does not respond to, or recurs in spite of, adequate quinine therapy is also suggestive of filariasis. In the male the detection of the slightest evidence of genital pathology—funiculitis, lymphangio-varix, hydrocele, etc.—indicates strongly the necessity of a search for the embryos as the possible cause of more vague and generalised symptoms.

The plea is made that every patient in whose case the diagnosis is not clear should be studied for filarial infestation as the sole or contributory cause of his or her symptoms. This can best be done by having the patient—with the help of a friend or relative—take 20 drops of blood into a 2 drachm bottle containing 5 c.c. of a 2 per cent. acetic acid solution; which can be centrifuged at the examiner's leisure—hours or months later, and a couple of drops of the sediment examined with the low power lens without preliminary staining.

2. Urticaria due to Filarial Toxin.

H. W. ACTON *and* S. SUNDAR RAO, Calcutta.

Urticaria is a manifestation of anaphylaxis usually produced by foreign proteins, either from food or from infections. It has not been generally known that it can be produced as the result of filarial (*F. bancrofti*) infection. Urticarial attacks due to filarial infection in endemic areas is a factor to be recognised, although the proportion of cases to the total infected population is small. In the cases studied the attacks of urticaria can be definitely ascribed to the filarial infection in the system, since other factors were carefully eliminated. The actual causative factor of the urticaria is the toxin discharged into the system by the adult worm in the process of laying embryos.

The intensity and frequency of the attacks differ in different cases and this appears to be due to the varying susceptibility of individuals. This difference in susceptibility of individuals is supported by the results of cutaneous reactions with filarial extract.

3. Further studies on the development of *Filaria bancrofti* in Mosquitoes of Bengal.

S. Sundar Rao *and* M. O. T. Iyengar, Calcutta.

During the last session of the Indian Science Congress the authors reported on the influence of climate on the development of *F. bancrofti* in *Culex fatigans*. They showed how the development was influenced both by low and high temperatures, and how the humidity affected the degree of infestation.

Since then, further work has been carried out which confirms the previous findings, and a series of comparative observations were carried out on experimentally fed mosquitoes placed under varying conditions of humidity and temperature. Other mosquitoes, including species of *Culex*, *Stegomyia*, and *Anopheles*, have been experimented upon and they showed varying susceptibility to the infection. The reasons for such variations are not well understood. These researches form part of a programme of experimental work to determine what species of mosquitoes in Bengal are capable of transmitting *F. bancrofti* and under what climatic conditions.

4. On the Physical Properties of the Serum in Filariasis.

R. N. Chopra *and* S. G. Choudhury, Calcutta.

Viscosity, surface tension, and density of about fifty samples of human sera were tested. The values for these properties fell within the range of those for normal sera. The buffer action of this type of serum is also being tested. It is concluded from these experiments that serum from the blood of a filariasis patient undergoes very little departure from the normal.

5. A case of Filarial Infection of the hand treated by deep X-rays.

Subodh Mitra, Calcutta.

Although filariasis is a common disease in India, filarial affections have never before been treated with deep X-rays. This case was definitely diagnosed by the finding of microfilariæ in the blood. There was a painful swelling on the dorsum of the left hand, with a sinus at the back of the root of the middle finger, constantly discharging a thin serous fluid. After deep X-ray treatment, the sinus healed up and became completely dry, and the swelling disappeared, leaving no residual signs. There has been no sign of recrudescence.

6. Equine Filariasis: A short review of the literature.

S. K. Sen, Muktesar.

The following are the main points discussed in the present résumé:—(1) Identity of the forms of microfilariæ recorded from the blood of equines; (2) relative incidence of microfilariasis in the horse and other species of animals; (3) the extent to which filariasis may be regarded as a morbid entity of any importance as affecting the health of the equine species; and (4) the therapeutic possibilities of the various forms of drug treatment hitherto devised.

A perusal of the available literature shows that only two species of microfilaria have been definitely recorded from the circulating blood of equines, namely. *Setaria equina*, Abildgaard, and *Filaria spirovoluta*, Smit and Ihle. Curiously, the young forms of *Parafilaria multipapillosa*, Cond. and Drouilly (=*Filaria hæmorrhagica*, Railliet) do not appear to have been observed in the blood of equines; as is well known, the adult filariæ of this species are of not infrequent occurrence in the subcutaneous connective tissue of these animals. As emphasised by Foley and his co-workers (1928), however, it must not be assumed that only one species of microfilaria is present, until the embryos occurring in the blood have been carefully compared with those in the terminal part of the uterus of the adult female, if the latter has been found. It is thus not improbable that a careful study on the lines recommended by Foley and his co-workers may result in the finding that in a certain proportion of the cases of equine microfilariasis, the embryos designated as *S. equi.* are in reality *P. multipapillosa.*

Whilst filariasis is of extensive occurrence in the dog, it is not so in the case of the equine species, as is illustrated by the fact that a systematic examination of 19,000 blood smears in a certain Remount Depot in India resulted in the parasites being "found only in six mules and five horses". The figures obtainable for the camel are from 4 to 22.5 per cent. in Turkestan and from 0.25 to 0.5 per cent. in South Eastern Russia, whilst in the Indian Region, "the disease is common in camels" (Cross, 1922–23).

In a great majority of the cases of equine filariasis recorded by various workers, no definite clinical symptoms have been reported, and in the few instances where this has been done, the symptoms were not such as could not be ascribed to causes other than filariasis. A number of workers have noted the occurrence of filariasis as a condition concomitant with other forms of blood infection (notably trypanosomiasis), where systematic examination of blood smears has been resorted to as a routine procedure (observations are cited to substantiate this), so that the possibility suggests itself that a more extensive search would result in the finding that a proportion of the animals normally harbour these parasites without developing any clinical symptoms.

From the descriptions given by various workers of the symptoms of equine filariasis, one finds it difficult to resist the impression that the disease is not associated with any clear clinical picture. Symptoms have been described which are characteristic of affections referable to widely different categories (*e.g.*, tryponasomiasis, glanders), or, else, except for the occurrence of eosinophilia (indicative of general verminous infections), the symptoms are so diffuse (*e.g.*, "debility", "wastage", "anæmia", etc.,) as to be applicable to a number of other affections, (Observations are cited).

In the absence of precise knowledge as to the pathogenic rôle played by the filarial embryos, the various forms of therapeutic treatment designed to combat the parasites have been mostly of an empirical character. In the course of his extensive experience with the disease, Wirth (1917) found that no special treatment was called for, as the disease generally ran a favourable course. Of the drugs employed, tartar emetic would appear to be the only one that holds out some promise of success.

7. On a new Trematode from the intestine of a Siluroid Fish obtained from the River Gomti at Lucknow.

G. S. Thapar, Lucknow.

A large number of specimens were obtained from the intestine of a Siluroid fish at Lucknow, and they belong to the family Opisthorchidæ. The form described here presents certain characteristic features which indicate that it is new to science. The chief peculiarities are :—

1. The body is covered over with spines.
2. There is a well developed elongated prepharynx, as long as the œsophagus.
3. The intestinal crura reach the posterior end of the body.

4. The excretory vesicle is an elongated straight tube, and does not show the S-shaped curve so characteristic of the genus *Opisthorchis.*
5. The ovary is in front of the two testes, and all three are situated one behind the other in a regular linear series.
6. The uterus is between the ovary and the acetabulum.
7. The yolk glands are in the middle third of the body, extending posteriorly in front of the testes.
8. There is no cirrus and no cirrus sac.

The paper concludes with a discussion on the present status of the family Opisthorchidæ.

8. On *Farzandia*, a new genus of Acanthocephalid Worms, from the intestine of Ophiocephalus sp.

G. S. THAPAR, Lucknow.

The writer (1927) described a new genus *Acanthogyrus*, and proposed a new classification for Acanthocephala, based on a natural system. Recently, the writer received from one of his pupils a very large number of Acanthocephala from the intestine of an Ophiocephalus. These, on closer examination, appear to belong to a new genus of the family Acanthogyridæ Thapar, 1927. The chief peculiarities of this form are :—

1. The proboscis is spherical and is armed with four alternate rows of eight hooks each.
2. There is a distinct neck present.
3. The body is armed with regular rows of spines. These spines for the first 8 to 10 rows are more closely arranged than over the rest of the body.
4. The genital organs have prostate glands which present a syncytial arrangement, with a number of scattered nuclei.
5. The ductus ejaculatorius is not Y-shaped, as in the genus *Acanthogyrus.*

A detailed account of the anatomy of the worm is given, and is followed by a discussion on the systematic position of the genus in question. It further supports the view already put forward by the author in his previous (1927) communication concerning the classification of the Acanthocephala.

9. On a new Cestode from the intestine of Lucknow Pigeons.

L. N. JOHRI, Lucknow.

(Communicated by Dr. G. S. Thapar.)

In the present communication a new species of *Houttuynia* is described. This form is found, along with other genera, in the intestine of pigeons in Lucknow, and has the following distinguishing features :—

1. The present species bears, just below the rostellum, a pair of lateral expansions armed with spines.
2. It also bears minute spines in front of the rostellar hooks.
3. The number of testes varies from 26 to 28, and is different from those of other species.

A detailed account of the anatomy of the worm is also given in the paper.

10. Helminthic Infections in Shillong.

A. N. SHARMA.

The author examined the stools of over 1,000 men in the Army and of 500 of the civilian population in Shillong during the period September to December. He attaches graphs giving his results, and also demonstrates a dozen slides illustrating ova found at Shillong.

MALARIA, PIROPLASMOSIS, LEISHMANIASES, AND LEPTOSPIROSIS.

11. Some observations on an unusual epidemic of Malaria in the city of Lucknow. (April-September, 1929).

A. C. BANERJEA.

The city of Lucknow, the largest in the United Provinces, having a population of 2,17,167 according to the census of 1921, a crude death rate averaging from 40–45 and a birth rate from 47–52 per 1,000 of population (1923–28), was visited by a severe outbreak of malaria in the summer of 1929. The fever rise started in the second week of March, reached the peak in May, declined in June, rose again in July and August and declined in the third week of September. The mortality following the high fever incidence was enormous and unprecedented, being almost 4 to 6 times the average for the corresponding periods of the previous four years. The town was surveyed in 1913 and in 1923, and the latter survey showed that the spleen rate had fallen from 3.5% in 1913 to 1.4% in 1923. There is no evidence to show that the town was ever visited by epidemic malaria before. Regarding meteorological conditions affecting the malarial incidence there are two important deviations from the normal of the previous three years :—(1) the year preceding the outbreak was one of drought; and (2) this year (1929) there was an excessive rainfall in the period from the middle of July to the middle of August, the excess being about 15″ above the normal.

The following in brief are the most important features of this outbreak :—

1. Occurrence of epidemic malaria in the so-called "benign malaria season".
2. High morbidity associated predominantly with *P. vivax* infections.
3. High incidence of the graver forms of malaria such as typhoid, remittent, abdominal, and a few cases of cerebral malaria.
4. Severe intensity of infection by *P. vivax* as seen in blood films from cases.
5. Absence of any marked corresponding increase in the carrier anophelines until May as determined by adult catch.
6. Association of only two carrier anophelines—*A. culicifacies* and *A. stephensi*—of which the latter only was found infected in nature.
7. Greater incidence in the central portions of the town which abound in wells, than in the outskirts and the portions bordering on the river.

12. Sur une Méthode pour Délimiter l'Étendue des Splénomégalies et Enregistrer d'une Façon Précise leurs Oscillations Ultérieures.

I. FROILANO DE MELLO, Goa.

During his experiments on the action of Plasmoquine on enlarged malarial spleens, the author had to face the difficulty of finding out how to record exactly the enlargement of the spleen, and to keep an accurate record of its reduction under treatment.

No reliable method is described in any of the books on epidemiology or tropical pathology; every author, every measurement, all vary in method. Only Christophers and his school have dealt with this question in a series of very important papers; but his method, utilising a standard abdominal chart in order to record the splenic index of a malarial community, does not solve the difficulty referred to above, as the method is based on two reference points, which are cutaneous and not fixed.

The technique adopted by the author is to trace for each individual a chart of natural size (which can later be reduced if necessary) in the following manner :—

(*a*) draw by palpation the outline of the spleen below the costal margin;
(*b*) mark on the median line the symphysis pubis, the base of the xiphoid process, and the median point of the manubrium sterni furca;
(*c*) mark the position of the antero-superior iliac spine;
(*d*) draw the left costal margin, by measuring the distances from its different points to a horizontal line crossing at right angles the above-mentioned median point of the furca;
(*e*) draw on the abdominal area two series of lines at 2 cm. intervals; the lines of the first series are parallel to the median line, and those of the second series are parallel to the pubo-iliac line.

By the technique described above one can easily mark out the outline of the spleen on the lines thus traced. On further examination, one has only to draw again on the abdominal area the outline of the spleen below the costal margin, and the parallel lines above referred to, and compare it with the outline previously traced.

The evolution of the splenomegaly in the leukaemias, Banti's disease, or under the action of the so-called spleen reducing medicines in a given patient can be fully and precisely investigated by this method.

13. The *Anopheles stephensi* problem in Calcutta.

B. C. BASU, Calcutta.

(Communicated by Lieut.-Col. R. Knowles, I.M.S.)

The prevalence of *Anopheles stephensi* has been studied for a period of one year in an area about one square mile in extent in Central Calcutta. The nature of the breeding places and habits of this species of mosquito, as studied in the area in question, are described. Correlation between the prevalence of this species in the area and atmospherical conditions. Short bibliography.

14. Some aspects of the behaviour of cinchona alkaloids towards living cells.

N. D. KEHAR, Kasauli.

The behaviour of quinine bihydrochloride and quinine bisulphate was studied on the living cells of *Nitella* (*Characeæ*), regarding permeability and electrical conductivity. Interesting results have also been observed with gelatin and agar-agar gels of definite concentrations, mixed with various inorganic salts that are supposed to be present in the living cells. Beautiful Liesegang rings are visible, showing remarkable differences with different salts of the alkaloid. An attempt has been made to correlate the physico-chemical and the bio-chemical aspects of the behaviour of these alkaloids on the cells in the system after quinine salts have been either injected or taken orally.

15. The diagnosis of "red water" (piroplasmosis) in Indian cattle.

HUGH COOPER *and* P. R. KRISHNA IYER, Muktesar.

An account is given of the existing methods for the diagnosis of "red water" in Indian cattle, both during life and after their death, and the limitations of these methods are briefly discussed.

It is not often possible to diagnose piroplasmosis in Indian cattle by microscopical examination of blood smears, or by the clinical symptoms regarded as characteristic of the disease. Nor is it possible to arrive at a correct etiological *post-mortem* diagnosis based upon lesions described in text books.

Some original observations made by the writers upon morphological changes displayed by *B. bigemina* during the course of their disappearance after death of the host are described, and an account is given of the writers' method of *post-mortem* diagnosis, based, in the absence of other lesions, upon a peculiar colour lesion of the kidneys.

16. On the differentiation of the Leishmania concerned in producing Dermal Leishmanoid from *Leishmania tropica.*

B. M. DAS GUPTA, Calcutta.

(Communicated by Lieut.-Col. R. Knowles, I.M.S.)

A culture of the leishmania parasite of dermal leishmanoid was injected intraperitoneally into a mouse, which developed visceral infection. A similar result was obtained by injection of a culture of *Leishmania tropica* by the same route, but in this case a nodule also resulted at the site of inoculation. This shows that very little assistance can be obtained by animal inoculation in differentiating species of Leishmania.

Attempts were next made to differentiate these and other species of Leishmania serologically by Noguchi's technique. The results were anomalous.

Finally, cultures were made on a modified Noller's plate medium, using the technique of Meyer and Ray. These showed a characteristic difference in the rapidity of growth between the two species.

17. The effects of Antimony Injections on the Viscosity of Kala-Azar Sera.

R. N. CHOPRA *and* S. G. CHOUDHURY, Calcutta.

During the course of injections of antimony compounds, the viscosity of the serum from the blood of kala-azar patients undergoes very little change. From the date of the first injection, until the patient was discharged from hospital, in the seven patients studied the value for viscosity in each remained constant.

18. An outbreak of Leptospiral Jaundice among the hounds in Madras.

V. KRISHNAMURTI AYYAR, Madras.

An outbreak occurred towards the end of December 1928 among the hounds in Madras, in which forty out of fifty-four succumbed to the infection.

The author had the opportunity to conduct post-mortem examination on most of them that died and the post-mortem appearances present were in every case characteristic and more or less uniform. Icteric condition of the visible mucous membranes, punctate haemorrhages in the lips and subcutis, sanguineous effusion in the thoracic and abdominal cavities, haemorrhages in the intestines, more especially in the jejunum and ileum, haemorrhages in the bladder, characteristic changes in the liver and the kidneys, both being pigmented yellow, haemorrhages in the lungs simulating the so called "butterfly appearances" so characteristically described as prominent lesions of leptospiral infections, formed some of the important lesions. Forms indistinguishable from Leptospira were found in one of the direct preparations made from the liver from one of the hounds, examined under dark-ground illumination, and this was confirmed later in a smear made from the liver of a guinea-pig inoculated with blood from one of the hounds suffering from the disease.

Sera from four of the hounds that recovered from the disease were sent by Mr. F. Ware, the then Director of Veterinary Services, Madras, to Dr. Lewthwaite, Medical Research Institute, Kuala Lumpur, for serological test, and these were found positive for *Leptospira icterohaemorrhagiae.*

The outbreak is the first of its kind to be recorded in dogs in India.

TUBERCULOSIS.

19. A note on the Innocuity and the Immunising Property of B.C.G. (Bacillus—Calmette—Guérin).

M. B. Soparkar, Bombay.

Experiments carried out on guinea-pigs, rabbits, and calves have shown that in a very large majority of instances inoculation of B.C.G. does not lead to the evolution of progressive tuberculous lesions and that the strain, in this sense, is not virulent. In two exceptional cases, however, the rabbits inoculated with B.C.G. died with marked tuberculous lesions in the organs. Study of the strain isolated from the lesions showed it to be of the bovine type.

Although a number of observers support Calmette's claim as to the innocuousness of B.C.G., a small group of investigators have observed progressive tuberculous lesions to follow inoculation of B.C.G., and Nobel maintains that under exceptional conditions B.C.G. is capable of producing fatal tuberculosis in laboratory animals.

Experiments on rabbits to test the premunising property showed that only a certain degree of protection was conferred on these animals by inoculation with B.C.G., and that both the vaccinated animals as well as the controls died of severe tuberculosis after a test dose of virulent bovine bacilli, though the vaccinated animals outlived the controls. Immunity experiments were also made upon cattle. Results showed that very little resistance was produced in Indian hill bulls by vaccination with 100 milligrammes of B.C.G. against a test dose intravenously of 5 milligrammes of a bovine strain, 8 out of 9 animals dying within 2 to 6 weeks of acute miliary tuberculosis. These results differ from those obtained by the Ukraine Commission, reported by Professor Tzekhnowitzer, which show that intravenous test inoculation of previously vaccinated animals with a similar dose of virulent bovine culture (Vallée) failed to produce any serious disease.

20. On the incidence and diagnostic value of enlargement of Cervical Lymphatic Glands in Pulmonary Tuberculosis.

M. Kesava Pai *and* C. A. Venugopal, Madras.

1. Enlarged cervical lymphatic glands are present in a large number of subjects, normal and abnormal.

2. They are present in a larger number of tuberculous subjects than in non-tuberculous subjects.
3. They are found more frequently in bacillus positive cases than in bacillus negative cases.
4. The presence of enlarged cervical glands may be considered as an additional evidence of pulmonary tuberculosis, but is not diagnostic of the disease.
5. Scrofulous glands are uncommon in subjects of pulmonary tuberculosis.
6. The enlargement of the glands is due to a condition of allergy, and not a true scrofula.

21. On the value of the suspension stability of red blood corpuscles in determining the Prognosis of Pulmonary Tuberculosis.

M. KESAVA PAI *and* P. K. GUNASAGARAM, Madras.

A synopsis of 222 cases of pulmonary tuberculosis treated in the Madras Tuberculosis Hospital, whose red cell sedimentation rates were recorded month after month for periods of two months to two years is given in the paper. Of 55 cases which showed an increase in the sedimentation rate of 30 or less, 2 only showed marked benefit, 25 slight benefit, and 28 became worse. Of 11 cases that showed an increase of over 30, none showed any marked improvement, only one benefited slightly, and all the remaining 10 became worse. Of 96 cases that showed a decrease of the sedimentation rate by 30 or less, 32 showed great improvement, 55 were relieved, and 9 became worse. Finally, of 60 cases that gave a decrease of over 30 in the sedimentation rate, 41 became remarkably better, 18 were relieved, and only one became worse. It is concluded that the fluctuations in the sedimentation rate are quite as reliable in judging the progress and prognosis of cases of pulmonary tuberculosis as the temperature, weight, and general symptoms.

22. On the relative frequency of Supraclavicular and Infraclavicular Pulmonary Tuberculosis, and its bearing on the prognosis of the disease in this country.

M. KESAVA PAI *and* K. VASUDEVA RAO, Madras.

A correct localization of lesions in early pulmonary tuberculosis should be made by rontgenology, as physical signs by themselves are not quite reliable. A study of 1497 cases of pulmonary tuberculosis treated in the Madras Tuberculosis Hospital and diagnosed by a combination of physical signs and skiagrams shows that the largest number of cases, viz., 457, are hilus affections, 389 subapical, 240 advanced involving more than one lobe and constituting stage III, 145 middle zone, 22 basal, and 4 alone supraclavicular. A large number of the cases including cavity cases gave a short history of six months or less, some being of shorter duration than one month. The prognosis of all these different classes of cases and of the three stages of the disease as judged by the results of treatment, was worse in the Madras cases, than that usually recorded in England and western countries. The investigation confirms the view that is now generally held that true apical localization as an initial lesion in pulmonary tuberculosis is very much less frequent than it was considered to be till recently. It also indicates that pulmonary tuberculosis is more acute and has a worse prognosis in India than in Europe and in western countries. This is very likely due to the poorer economic, social, and food conditions here than in Europe, and not to any difference in racial immunity between the two countries where the disease has existed an equally long time for several centuries.

23. Some surgical aspects of Tuberculosis.

ERNEST F. NEVE, Kashmir.

The writer, after referring to the dicta of an eminent physician and specialist in tuberculosis, on "the distressing aftermath" of surgical interference in tuberculosis, proceeds to review surgical experience in the Kashmir Mission Hospital in connection with the treatment of various forms of the disease. The nature and origin of tuberculous adenitis is discussed, and the best methods of treatment outlined, with special reference to the general principles governing operation. Three thousand cases have been treated, with an operative mortality of 0.5 per cent., and complete success in approximately 75 per cent. of the cases.

Brief reference is also made to the treatment of tuberculous bones, joints, and cold abscesses, in which now such excellent results are being obtained by early incision, with closure of the wound, heliotherapy, and rest,—results which contrast so favourably with those obtained at the beginning of the century.

24. The Value of Phrenic-exairesis in the Treatment of Pulmonary Tuberculosis.

C. FRIMODT-MOLLER *and* DAVID V. GNANAMUTHU, Arogyavaram, near Madanapalle.

A short history of the operation is given, the technique is described, and the indications for the operation are stated.

104 patients have been operated on at the Sanatorium. Detailed analysis is given regarding the influence of phrenic-exairesis on clinical symptoms such as fever, cough, and sputum, on the presence of T. B. in the sputum, and on the general condition of the patients.

Our experience is that the operation is of value in the treatment of selected cases of advanced pulmonary tuberculosis. In those cases where the phrenic-exairesis was performed as an accessory to artificial pneumothorax treatment the result was that even of the cases in stage III C, that is, in those with the worst prognosis, 13 out of 21 were benefited, 8 or 38 per cent. of these being "much improved". In those cases where the operation was done as the sole procedure, 15 cases out of 28 in stage III C were benefited, 4 of these being much "improved". The results obtained in the less advanced cases, although these were chiefly cases in stages III A and III B, were considerably better as shown in the detailed analysis given.

25. The significance of Spirochætes in sputum, with special Reference to Pulmonary Tuberculosis.

P. V. BENJAMIN, Arogyavaram, near Madanapalle.

Spirochætes in association with fusiform bacilli must be considered normally present in the mouth. They were found in 93 per cent. of gums examined, and in 34 per cent. of tonsils. The frequent presence of these organisms in the sputum is due to contamination from the mouth. The sputum of 331 patients has been examined without previous washing of the mouth and the sputum and spirochætes were found in 59 per cent. of these cases. On the other hand, in 170 cases where the mouth and the sputum were first washed, spirochætes were found in the sputum in only 3 or 1·8 per cent.

Among these 170 cases, 162 were patients with pulmonary tuberculosis. Out of these 162 cases, 17 were complicated with hæmoptysis, 122 with cavities in lungs. In as much as spirochætes were not found in any of these 162 cases, except in one, it is not likely that spirochætal infection has any significance regarding complications with hæmoptysis, or with secondary infections in cavities, in pulmonary tuberculosis, as is claimed by some other investigators.

Bronchitis was a complication in 14 of these 162 cases; 6 of these had no T. B. in sputum, and 2 with T. B. in sputum had hæmoptysis. In the sputum of none of these were spirochætes found.

Out of the 170 cases, 8 were non-tubercular: 6 of these were suffering from unresolved pneumonia or beginning bronchiectasis. In none of these were spirochætes found. The remaining 2 were suffering from lung abscess, in both of these spirochætes were found repeatedly. This suggests that the finding of others that lung abscess is caused by spirochætes is correct.

OBSTETRICS AND GYNAECOLOGY.

26. Some observations on the incidence and mortality from Eclampsia in Calcutta, and its prevention.

GRACE STAPLETON, Calcutta.

On investigation of all cases of eclampsia treated at the Dufferin Hospital, Calcutta, in 1927 and 1928, the following facts emerge:—

1. The incidence of this disease is very high, for 65 cases occurred out of a total of under 1,200 deliveries.
2. The majority of the cases are young primigravidae of 20 years of age and under.
3. The death rate among the young women is double that of the older patients; viz., 26 and 13 per cent. respectively.
4. Premonitory symptoms are present in at least 75 per cent. of the patients, often as early as one to four months before the occurrence of the fits.

As the disease is one of the toxaemias of pregnancy which can be largely prevented by adequate medical supervision throughout pregnancy, and especially in the last three months, there is urgent need for organised effort by medical practitioners and health authorities, and for special propaganda to cause the lay public to appreciate the need for antenatal attention. If efforts were made to raise the age of consummation of marriage, so as to avoid the risk of pregnancy until the woman's physical development is completed, there would be a much smaller incidence of eclampsia.

27. The place of non-specific Protein Therapy in Gynaecology.

V. B. GREEN-ARMYTAGE *and* D. N. MITRA, Calcutta.

Non-specific protein therapy was practised in its earlier days in a limited number of cases, such as chronic joint affections. In the present paper the authors describe how protein shock therapy can be utilised in obstetrical and gynaecological practice.

Prof. Hof Bauer has pointed out the natural defensive mechanism within the pelvis in the form of the "guardian cells" of the parametric tissue. These increase in strength and number after conception, presumably due to protein shock. Injection of a foreign protein, such as milk, can be utilised to awaken the activity of these cells when their growth is urgently called for. In this way milk can be injected prophylactically and therapeutically. Experience also shows that injection of milk gives rise to reactions, febrile or not, depending on the nature of the infection responsible for the gynaecological complaint for which surgical interference may be demanded, *e.g.*, proved cases of suppuration. Thus it is possible to say whether the infection is streptococcal or otherwise, or whether it is advisable to operate with safety.

As regards lower Caesarian section (extra-peritoneal), it has been our experience in India that it is necessary in the majority of cases of difficult labour in India, because most of them when they come to the qualified man are definitely septic. The other methods of confinement in these cases were fraught with numerous risks to the lives of both mother and child. But it has been proved that the wound made in the lower uterine segment, being in close proximity to the "guardian cells" mentioned above, is not only more helpful in producing a living child, but is also far less likely to be followed by fatal sepsis in the mother.

28. On the Anaemia of pregnancy.

SUBODH MITRA, Calcutta.

Sixty cases of anaemia of pregnancy have been studied during the last three years in the Seva-Sadan Women's Hospital in Calcutta. There is an absolute mortality of 23.3 per cent., but if the patients who went away not fully treated, against medical advice, are considered as having died or not been cured, there would be a relative mortality of 44.9 per cent. Foetal mortality is 50 per cent. Almost all the cases belong to the Hindu community, with the exception of two Mahomedan patients. The disease is more common in multiparae, the ratio being 3 to 1. The youngest patient was 14 years old, the oldest being 40 years of age, and 75 per cent. of the cases between 15 and 25 years of age. A seasonal influence was also noticed, the disease being more common during the latter half of the year. Premature birth is a common phenomenon in the anaemia of pregnancy; about 66 per cent. of such premature births occurring between the 6th and 8th months of pregnancy. With regard to prognosis, cases with oedema react well after confinement. In the series considered, 80 per cent. of patients had oedema, and there was a mortality of only 20 per cent. among these. In dealing with anaemia cases, in addition to the usual routine treatment, adrenalin is pushed, and deep X-ray applications given to stimulate the reticulo-endothelial system, with apparently satisfactory results.

29. The results of Radiotherapy on Uterine Fibroids and Metropathia Hæmorrhagica.

SUBODH MITRA, Calcutta.

Observations have been made on 190 cases, of which 109 were cases of uterine fibroids, and 81 cases of metropathia hæmorrhagica. Amongst the fibroid tumours, the interstitial variety of any size gave the most satisfactory results with radium, whereas the sub-peritoneal variety also showed signs of retrogression. The author's technique of treatment differs somewhat from that in other clinics. Generally, he uses intrauterine application of radium, supplemented by deep X-ray therapy, if necessary. The so-called contra-indications to radium treatment have been reduced to a mininum by careful preliminary treatment. Judging from results, radium and deep X-ray therapy form the treatment of choice in fibroids and metropathia hæmorrhagica, except in only a very small percentage of cases, where surgical intervention may be necessary.

30. Two hundred and sixty cases of Carcinoma of the Cervix Uteri treated with Radium and deep Roentgen-rays.

SUBODH MITRA, Calcutta.

During the last four years, 260 cases of carcinoma of the cervix uteri have been treated with radium and deep X-rays. Although it is too early to give a definite pronouncement, the clinical progress has been very satisfactory. Hæmorrhage stops, and the offensive discharge disappears in more that 80 per cent. of cases. In about 75 per cent. of cases the growth, whether proliferative or ulcerative, disappears, but in advanced cases reappears after some months or years. Unfortunately in India, more than 95 per cent. of cases come for treatment when they are not only inoperable, but in a very advanced condition. Cases in the operable stage give very satisfactory results.

BACTERIOLOGY, VACCINES, ENTOMOLOGY, AND MYCOLOGY.

31. The Protein Reactions of Bacteria.

S. N. GORÉ, Bombay.

The protein reactions referred to here are the production of indol, hydrogen sulphide, and nitrite. They are detected in the same peptone culture by the method described by Goré in 1925.

The first two reactions have been shown to be of great utility in the grouping and presumptive identification of intestinal bacilli.

The third one, *viz.*, nitrite production, has been found to characterize *B. pestis;* above all it has enabled a cultural differentiation to be made between the smooth and rough variants of fowl cholera.

This latter finding appears to be a sufficient reason for an intensive study of such reactions, with a view to determine the extent of parallelism between protein reactions—*in vitro* and *in vivo.*

The indolic character is associated mostly with the commensals, though in some cases with a few pathogens, such as the *B. dysenteriae* (Flexner), *B. morgani*, *B. asiaticus*, *B. columbiensis.*

Hydrogen sulphide is produced by many putrefactive and pathogenic bacilli, such as *B. typhosus*, *B. paratyphosus* B and C, *B. enteritidis.*

The nitrite production character is associated with the cholera vibrio, *B. pestis*, *B. diphtheriae*, and some members of the hæmorrhagic septicaemia group of bacilli.

32. Certain errors in the standardisation of Bacterial Vaccines by the Opacity method.

V. GOVIND RAJU, Calcutta.

The numerical estimation of the bacteria present in an emulsion by the opacity method is subject to a serious error, arising out of the tendency of bacteria to lyse. Some bacteria lyse out more quickly than others, and in the case of some the lysis is so rapid that in a week's time the opacity test gives only a third of the true reading, when the vaccine is kept at room temperature. When kept, however, at the low temperature of 32° F., and protected from light, the lysis is much less rapid. The above finding leads to the conclusion that the opacity test, if it is to be accurate, must be carried out immediately the emulsion is prepared, and that, if this is not possible, the vaccine may be kept for some time unaltered if it is protected from light and stored at a temperature of 32° F.

33. Chemical and Bacteriological qualities of Bengal Tube-well waters.

V. Govinda Raju, Calcutta.

Both bacteriologically and chemically these sub-artesian tube-well waters yield very characteristic results. Bacteriologically, they are practically germ-free, and generally do not show lactose-fermenters in even 60 c.c., and when these are present, they are mostly of the *cloacae-aerogenes* type. Chemically, they are practically free from organic matter, and generally show free ammonia much in excess of that found in surface waters. Iron is often present, from a trace up to even 0.6 part per 1,00,000. The chlorides are low, except when situated near rivers subject to tidal action. The hardness, mostly due to bicarbonates, is about 25 parts per 1,00,000, but may be more near tidal areas. The increase in chlorides and bicarbonates in the tidal areas is perhaps due to the soil in these areas being impregnated with saline matters, and not to direct admixture of saline river water. No seasonal variation has been observed in either the chemical or bacterial constituents. When locating these tube wells near tidal rivers, it is advisable to locate them as far away from the river itself as possible.

34. Études Expérimentales sur la Valeur Prophylactique de la Vaccination Orale Antityphique.

I. Froilano de Mello, Goa.

Enteric fever being endemic in Portugese India, and assuming epidemic proportions especially after the monsoon, specific vaccination has been strongly recommended by the health authorities. This measure was largely used by medical practitioners and well accepted by the people; whereas the previous introduction of oral vaccination failed in some cases, and thus became discredited, especially in rural areas.

The problem being very important, on the invitation of the Bureau at Singapore, the author has carried out during the past two years a series of laboratory and field experiments to test the value of the oral vaccination.

These studies may be summarised as follows :—

1. The laboratory tests generally employed for antibody formation do not give sufficiently definite and uniform results to enable one to judge the value of oral vaccination.

(*a*) The Widal test has been negative or highly irregular, both in men submitted to this method of protection, and in white rats proved to be undoubtedly protected against the further injection of a lethal dose of *B. paratyphosus* B.

(*b*) The sero-flocculation test of Ramon *vis-a-vis* the filtrates of T. A. & B. bacilli has given the same irregular results.

(*c*) The dermo- and intradermo- reactions have been either negative, or at variance with the Widal test.

2. Epidemiological studies among the immunized are thus the only means for judging the real value of such vaccination.

Three series of experiments were carried out.

(*a*) Vaccination among the entourage of typhoid patients, excluding systematically all those who had previously suffered from an attack of remittent fever during the previous fifteen years, or had been orally or parenterally vaccinated during the previous two years.

(*b*) Vaccination *en masse* of the inhabitants of a ward where cases of typhoid fever were registered every year in October to December, excluding those considered to be protected, (*vide supra*).

(*c*) Vaccination *en masse* of whole villages where cases of typhoid fever have been occurring only during the past five years.

A careful comparison of the incidence of the disease among those groups and those non-vaccinated shows that oral vaccination, although not infallible as far as personal immunity is concerned, has its full value in checking an epidemic, and combating epidemic disease in affected areas.

35. Some observations on Bacterial variation in a strain of *Pasteuralla suiseptica.*

J. T. CORNELIUS, Lucknow.

A stock strain of *P. suiseptica,* N.C.T.C. No. 931, has been tested for agglutinability, and two variants, one agglutinable and the other inagglutinable, were isolated and 20 single colony cultures from each were tested six times for agglutinability on the principle of selecting the most agglutinable and the least agglutinable from each variant. Between these single colony cultures marked variations in agglutinability have been found.

The evidence suggests that by repeated successive sub-cultures, opportunities for growth and variation are afforded and the inagglutinable variant finally yields practically as many agglutinable colonies as the agglutinable variant.

2. The agglutinable colony variant is thin and translucent and the inagglutinable colony variant is dense and opaque, the former grows with the supernatant clear in broth and the latter diffuse.

The agglutinable colony variant yields only translucent colonies when plated, whereas the inagglutinable colony variant yields mucoid colonies and translucent colonies in about equal numbers, and the daughter mucoid colonies yield both types of colonies and the translucent colonies only the translucent type.

The effect of immune serum and of augmentor on this form of bacterial dissociation were studied.

3. In the viability tests carried out on these two variants, it has been found that there is a real difference in the dilutions in which one will grow and the other will not; and in the number of bacilli found in 1 c.c. of broth culture of each.

It is suggested that surface tension requirements of these two variants may be different.

Thus it would appear that the culture is heterogeneous with regard to the agglutinability of its constituent organisms, and when agglutinable culture becomes inagglutinable, it is being gradually replaced by organisms of a low degree of agglutinability with the appearance of two variants, showing discontinuous variations in agglutinability, colony morphology, and viability.

36. Tick infestation in the coastal tract of North Kanara District.

R. N. NAIK, Muktesar.

The writer has carried out an investigation into the extent and intensity of tick infestation in the coastal tract of North Kanara District, and has found that the infestation constitutes one of the most serious scourges that the livestock owner has to contend with.

The following species of ticks have been found by him to occur in the tract referred to :—

(1) *Baemaphysalis bispinosa,* Neumann. (2) *Haemaphysalis spinigera,* Neumann. (3) *Boophilus australis,* (Fuller). (4) *Rhipicephalus haemaphysaloides,* Supjno. (5) *Amblyomma integrum,* Karch. (6) *Hyalomma aegyptium* S. sp. *isaaci,* Sharif.

Certain facts are discussed concerning the correlated influence of climatic conditions on tick metabolism and infestation. Tick infestation has been found to attain its highest intensity during wet and hot-damp seasons; a temperature of 75°F to 85°F with a humidity of 75 to 90 per cent. has been found to be the optimum condition for the acceleration of the metamorphosis of ticks found in the tract, this being in confirmity with the "water-optimum" theory propounded by Headlee (1917).

Apart from the various injurious effects now known to be caused by ticks and dealt with at some length in the present paper, the writer refers to a new condition—termed by him, tick toxaemia—which would appear to be caused by the toxicity of the saliva injected by ticks during the act of feeding.

The problem of tick infestation in North Kanara District assumes a position of paramount importance by reason of the enormous loss it causes to the stock-owner. The average rate of mortality due to it alone has been estimated at not less than 5 per cent. The quinquennial cattle census for the last 15 years has revealed that on account of this infestation there has been no increase in the cattle population of the tract during this period, in spite of the fact that not more than 100 animals have been slaughtered for meat annually and that more than 3,000 animals have been imported every year.

Suggestions are made concerning remedial and control measures, including the introduction of arsenical dips, which have appeared to the writer most suitable for adoption in these tracts, having regard to the economic condition of the people.

37. A preliminary report on an investigation into fungoid affections of domestic animals in India.

S. DATTA, Calcutta.

The present work was started at the suggestion of Lieut.-Col. H. W. Acton, I.M.S., with a view to study the relationship of the fungoid diseases of man to those of the domestic animals. The clinical materials were obtained from the hospitals attached to the Bengal Veterinary College and the Calcutta C.S.P.C.A. The facilities for laboratory work were kindly provided by the Calcutta School of Tropical Medicine, and helpful encouragement was received from the Director of that School.

At the outset, it was realised that our knowledge with reference to the fungoid affections of domestic animals was very meagre, and therefore preliminary work on animal infections was necessary before the subject of their relationship to human diseases, and importance in such a connection, could be investigated.

The first investigation carried out was on the so-called "worm rashes". Cultures were obtained in seven cases. In one case where the fungus was thoroughly worked out, it had the following characters:—

(1) Intercalary chlamydospores. (2) Loops and spirals. (3) Dissociated or free spores. (4) Lateral chlamydospores, sessile. (5) Mycelial herniae. (6) Bodies resembling pectineal organs. (7) Perithecium. (8) Chandelier arrangement of branching.

This parasite resembles *Eidamella spinosa* of Matruchot and Dassonville (1902), but differs in the character of the spines around the perithecium.

The culture was inoculated into healthy dogs, and the author was able to reproduce the lesions and recover the fungus back again in pure culture.

A second line of research was the investigation into the cause of the so-called "milk sores" of puppies. So far no definite conclusions have been arrived at.

At present this work has only recently been commenced, and these few examples are given as illustrating the possibilities of research work upon the mycotic diseases of the skin in animals.

INTESTINAL DISEASES.

38. Notes on the pathogenesis of sprue and the asthenic diarrhoea of Indians, with especial reference to the role played therein by amoebiasis. The probable identity of the two former conditions, and their connection with Addisonian anaemia—subacute combined degeneration of the cord—Hunterian glossitis syndrome of Hurst.

J. B. Hance, Western India States Agency.

Recent work by Hurst and others has established the pathogenic connection of Addison's anaemia, subacute combined degeneration of the spinal cord, and Hunterian glossitis. The first two have a common origin in intestinal infection by a haemolytic streptococcus in subjects of achlorhydria, the haemic or neural condition dominating the picture according as the haemolysin or neurotoxin predominates in the toxins of the bacterium concerned; the third condition is a feature and physical sign of both.

Sprue has long been known to show an Addisonian blood picture, as has asthenic diarrhoea. Addisonian anaemia is equally well known for its gastro-intestinal symptoms. All three conditions are associated with paraesthesia of the hands and feet, and other signs and symptoms of subacute combined degeneration of the spinal cord.

An analysis of 17 consecutive cases of Addisonian anaemia affords evidence, clinical, pathological, and therapeutic in favour of the thesis propounded in the title, and moreover suggests that the essential feature is the intestinal ulceration and the infection of these ulcers with haemolytic streptococci, and that amoebic ulceration is as common a precursor as is that due to the dysentery bacilli. It is further suggested that, whereas Hurst and his colleagues blame a duodenal streptococcus, there is evidence that a colonic streptococcus can be equally culpable.

These suggestions are put forward in no spirit of dogmatism, but with the object of eliciting the views and experience of others in this important connection.

39. The Pathology of chronic colitis in the Tropics.

T. Bhaskara Menon, Madras.

From a study of autopsy material it would appear that the pathological lesions in the large majority of varying clinical conditions known as chronic colitis, and many cases of chronic diarrhoea, are identical with those of chronic dysentery, bacillary or amoebic. The variations in the clinical picture can be explained by the virulence and type of the infective agent and the individual factor. The different types of dysenteric lesions are also described.

40. A note on six strains of atypical cholera-like vibrios isolated from waters in the Madras Presidency.

T. N. S. Raghavachari, *and* S. V. Ganapathi Ayyar, Madras.

1. Five strains of atypical vibrios from well and tank waters in the districts of Madura, Ramnad, Salem, Tanjore, and Guntur and one from the protected water supply to the City of Madras were studied.
2. The Madras City strain was found to differ from the rest in that it was not fatal to guinea-pigs and did not agglutinate with the serum of

the true *V. Cholerae*, nor with any of the five sera prepared from the other five strains.

3. These latter were all fatal to guinea-pigs and did not agglutinate either with the true *V. Cholerae* serum or with that of the Madras City strain. They agglutinated with their respective sera and with that of one another.

4. The Madras City strain was isolated with great regularity almost every day for over one year, from the water of the Red Hills lake, both before and after chlorination. It was also recovered several times from the effluents from the slow sand filters as also from public taps on the distribution system. There was no *epidemic* of cholera during this period in the City, which could be attributed to these vibrios.

5. This strain of atypical vibrio which was found to resist chlorination and slow sand filtration was subjected to the action of weak and strong acids in varying dilutions, a strain of recently isolated *V. Cholerae* serving as a control. The atypical strain was found to resist the action of weak solutions of organic acids for 15 to 30 minutes, while the true *V. Cholerae* died out in the same strengths in under 3 minutes.

6. The constant presence over a long period of this hardy strain of atypical water vibrio in a protected water supply without producing any apparent ill-effects, makes it difficult to estimate the Sanitary quality of waters showing atypical vibrios.

DIETETICS, DIABETES, DEFICIENCY DISEASES.

41. The Digestibility *in Vitro* of the Proteins of the Pigeon Pea, (*Cajanus indicus*).

P. S. Sundaram, Bangalore.

The protein of the pigeon pea is less readily digested by pepsin and trypsin than is casein under the same conditions. If the digestibility is expressed as the percentage which the amino N liberated by the action of pepsin for two hours, followed by trypsin for three hours, bears to the amino N liberated by complete hydrolysis with acid, it is found that, while casein is digested to 68 per cent., the pigeon pea globulins are digested only to 58 per cent., if raw, and to 63 per cent., if cooked in water before digestion. Cooking in dilute alkali did not appreciably improve the digestibility. It was observed, however, that the digestibility was increased by 5 per cent., if the seeds were gently fried, and by 13 to 15 per cent. if the seeds were allowed to undergo incipient germination for 48 hours prior to cooking and digestion.

42. A note on the possibility of the use of Insulin by the mouth in Diabetes.

Harendra Nath Mukerjee, Calcutta.

By administering by the mouth insulin phosphotungstate precipitate, suspended in water, a definite lowering of the blood sugar has been observed in healthy rabbits, and also more markedly in diabetic patients.

43. On the Advisability of a Routine Wassermann Reaction in every case of Diabetes Mellitus.

H. Stott, Lucknow.

1. At the Annual British Medical Association Meeting at Manchester in 1929, Professor A. S. Warthin, Director of the Pathological Laboratories in the University of Michigan gave a summary of his findings of the lesions of latent syphilis in the various body organs, which have formed his

intensive study for the last 23 years, and of which he is justly so recognised an authority.

2. As regards the pancreas, Professor Warthin found that the lesions of latent syphilis were frequent, usually in the form of a mild interstitial pancreatitis not arising from the ducts. Moreover, this interstitial pancreatitis was the most common form of pancreatic disease found in diabetic post-mortem material.

To the naked eye, in severe cases the organ was small, and much firmer than normal, except where there was marked œdema of the interlobular stroma, when the organ was usually larger and softer. Professor Warthin therefore believes that this interstitial pancreatitis of acquired syphilis may be one cause of pancreatic insufficiency. He also found that syphilitic pancreatitis with the presence of spirochætes and with varying degrees of fibrosis is frequently of congenital origin, and may cause pancreatic insufficiency early in life.

3. These interesting findings of Professor Warthin support the views which we, in Lucknow, in our diabetic investigations have held and taught for many years past. We believe that even in a fat diabetic of the alimentary type the insulin producing power of whose pancreas is in the majority of cases, worn out by prolonged over work, the superadded factor of syphilitic pancreatitis not infrequently aids in the pancreatic insufficiency. Moreover, we find that in our series of 100 cases of diabetes, those under 25 years of age shewed a definitely higher positive Wassermann rate of 50% as compared with a positive rate of 32% in those over 25 years of age, pointing to the fact that the pancreas is affected more often in hereditary syphilis than in the acquired disease, and hence to the fact that syphilis is of special ætiological importance in the more serious type of diabetes of children and of adolescents. Syphilitic brain lesions too may lead to glycosuria, in the same way as any other brain tumour or other lesion.

4. Further, clinically, diabetics under our treatment with a positive Wassermann have improved more rapidly and to a greater extent, when placed on anti-syphilitic remedies, than when they were treated by diet and by internal remedies alone. In one case indeed, the glycosuria entirely cleared up permanently with anti-syphilitic treatment alone unaccompanied by any dietetic restriction. The possible danger of giving salvarsan to severe diabetics will be remembered, for one case of syphilis with serious diabetes went into coma after 0·35 gram salvarsan.

5. The pathological, serological, and clinical evidence therefore all point to the importance of a routine Wassermann test in every case of diabetes. For if this reaction be found positive, the patient will undoubtedly benefit materially if the syphilitic factor, which must unfavourably affect his pancreatic sufficiency, be removed.

44. On the distribution of Lathyrism in the United Provinces and on its cause, with a description of a 4¾ months' feeding experiment on Tonga ponies with Botanically pure cultures of Lathyrus, Sativus, and of Vicia Sativa.

H. Stott, Lucknow.

I. *Distribution of Lathyrism in the United Provinces.* There are three recognized areas of lathyrism in the United Provinces.

(1) In Shankergarh and other villages near Allahabad, which is not far removed from Rewah State, a notorious centre of lathyrism.

(2) Generally in the Eastern Districts of the Province, becoming most marked in Ballia the most Easternly Province of all, where it is continuous with an area in Bihar and Orissa, north of the Ganges similarly, and perhaps to a still greater extent affected.

(3) In the Districts of the Himalayan foot hills, where amongst the villages of one area in Khere, the endemic proportion affected was in the neighbourhood of (0·5 to 1·0) per 1,000. The western Districts of the United Provinces and south of the Ganges in Bihar and Orissa are so far as is known practically free of the disease.

II. *Distribution of Lathyrus Cultivation in the United Provinces.* Though the parallel is not very marked between the areas as reported under Lathyrus cultivation and the known distribution of the disease, on the whole there is some relationship which would probably be far closer if the returns were of greater accuracy.

III. *Distribution of the disease in man and animals.* Both are affected. Males apparently more than females. Horses are particularly susceptible.

IV. *The cause of Lathyrism.* Throughout the centuries in diverse countries the disease has been connected with the consumption of lathyrus pea in sufficient quantity over a sufficient time. Acton indicated from experimental work that the actual poison was a water soluble amine of the lathyrus crop by soaking the grain for 24 hours in three changes of water (*I. M. G.*, Nov. 1922) which increased during germination and which could be removed from Lathyrus. A bazaar specimen of lathyrus contained several distinct varieties of peas from which they separated amongst others two of special importance *Lathyrus sativus* and *Vicia sativa* both of which they cultivated in botanically pure culture. They concluded that lathyrus was chemically free from alkaloids and that the controlled feeding experiments over long periods with ducks and monkeys showed that the grains were harmless and even nourishing to these animals. They found that *Vicia sativa,* a weed contaminating lathyrus crop possessed alkaloidal bases, which were toxic to guinea-pigs, monkeys, and ducks. The experimental work of many other workers gave discordant results as to the poisoning power of Lathyrus, and it appeared as though the presence or absence of this contaminating weed might account for the variation noted.

V. *My Tonga Pony experiments.* Was the cause of Lathyrism residual in *Lathyrus sativus,* or in the contaminating weed *Vicia sativa*? It is of the utmost importance to decide this point, for in famine periods, when vast outbreaks of Lathyrism are apt to occur, the effective preventative steps to be advised differ according to which pea is actually responsible. Therefore, I devised the following experiments and, in consultation with Mayer Anderson, I.M.S , of the Central Research Institute, Kasauli; Mr. J. Edwards of the Imperial Institute of Veterinary Research, Muktesar; Captain Hickey of the Civil Veterinary Dept., United Provinces, put it into effect. Three healthy tonga ponies were purchased in the bazaar and kept for a period in quarantine. Their ages (2 years 3 months), sex (male), height (10–3), girth (48 inches), shank (6 inches), weight (50 seers) and condition (fair) were approximately the same and the ponies were seen at fortnightly intervals by Captain Hickey who recorded their progress. I saw the ponies daily at one feed and weekly at trotting and cantering exercise. To each pony the same basic diet was given, namely three pounds of barley with salt, a handful of lucerne when available and grass feeding ad lib. To No. 1 Pony, a chestnut, named "Vicia ", three pounds of *Vicia sativa* daily were given mixed in the basic diet. To No. 2 pony, a roan named "Lathyrus", three pounds of *Lathyrus Sativus* daily were given mixed in the basic diet. To No. 3 pony, a starred chestnut named "control", the basic diet only was given. The Lathyrus and Vicia were grown in botanically pure culture at the Institute of Plant Industry, Indore, Central India, and these pure strains I was able to obtain through the courtesy of the Director, Mr. A. Howard, C.I.E. A daily register was maintained of each pony's feeds, exercise, and condition. Each feed was mixed and given in the presence of Dr. R. S. Lal, Demonstrator in Pathology in King George's Medical

College, to whom I am indebted for this considerable help. The amount of any feed left by the animal was entered in the register. It was expected from the experience of previous outbreaks of Lathyrism in horses that with this doseage of the pea symptoms of lathyrism would appear in one or at the most two months.

The experiment started on 12th Nov. 1928 and was continued until 6th April 1929, that is for 4 months 24 days, when it had to be discontinued owing to the exhaustion of botanically pure strains of the grain. At the end of this period, all ponies were in equal and excellent condition and had put on weight. At no time did they show any evidence of disease either at rest or during or after exercise.

VI. *A plea for further research.* I conclude therefore that the experimental proof of the factor in a Lathyrus crop which causes lathyrism is not yet complete, and I urge that further research may be devoted to the solution of this urgent problem.

PHARMACOLOGY, PHYSIOLOGY.

45. An investigation into the action of Musk in Ether on the Frog's heart.

N. M. BASU *and* P. C. GUPTA, Calcutta.

This investigation was undertaken with ampoules of musk (each containing gr. 1/4 dissolved in 1 c.c. of ether) supplied by the Bengal Chemical and Pharmaceutical Works. The musk contained in one ampoule was poured into 10 c.c. of Ringer's solution; 1 to 4 c.c. of this solution was then added to 250 c.c. or so of Ringer's solution, which was then perfused through a frog's heart at a constant pressure of 1½″. A simple device was invented for placing the lever exactly tangentially to the drum, and also errors due to varying friction of the writing lever were removed. The tracing thus obtained corresponds exactly to the movements of the heart. It was found that when the concentration of the musk was 3/110 gr. in 100 c.c. of Ringer's solution, the heart beats, which were slightly irregular, quickly became regular after perfusion with the musk solution was commenced, and within 20 to 25 minutes the beats were markedly augmented, and this condition was maintained for a long time. At a slightly higher concentration there is an initial temporary depression, but afterwards the normal beat is maintained for a long time. When the concentration of musk is 2/ 55 gr. in 100 c.c. of Ringer's fluid, or more, the heart beat is depressed both in force and frequency within a short time, but the normal beat can be restored if the perfusion is not continued for a long time.

46. A comparative study of the action of Cobra Venom and Tincture of Digitalis on the Frog's heart, and a note on the effect of Cobra Venom dissolved in Calcium-free Ringer's solution on the Frog's heart.

N. M. BASU *and* P. C. GUPTA, Calcutta.

Perfusion of the frog's heart was carried out in the same way and at the same pressure as in the investigations with musk.

When the heart is perfused with calcium-free Ringer's solution, ventricular contraction ceases within three minutes, and the auricular contraction also becomes very feeble; but if cobra venom be added to the calcium-free Ringer's solution, the heart beat is depressed and slowed, but it is maintained for a long time. At this stage, if the heart be-perfused with a solution of venom in Ringer's fluid, the beat is immediately augmented and accelerated. Cobra venom therefore compensates to a great extent for the absence of or a deficiency of calcium in the perfusion fluid.

In comparing the continued action of Digifortis or tincture of digitalis with that of cobra venom, it was noticed that:—

1. while digitalis acts slowly, cobra venom acts almost instantaneously.
2. while digitalis augments and markedly slows the heart beat, cobra venom also augments the heart beat, probably more markedly, but does not slow it to the same extent.
3. while the continued perfusion of digitalis brings about fibrillation of the heart muscle, continued perfusion of cobra venom causes gradual slowing and inhibition of both auricular and ventricular beats, and then stoppage of the. ventricular contraction before the heart finally completely ceases to beat.

47. On the Biological Reaction of X-rays upon the Indian skin, and the standardisation of X-ray dose according to the International Standard of "r" Unit.

SUBODH MITRA, Calcutta.

This biological reaction has been studied with the special Tropical Stabilivolt apparatus for Roentgen therapy. The author has formulated his own standard of skin-erythema-dose (Seva-Sadan standard). This standard has been obtained in 25 minutes, while working with 180 K.V., 4 M.A., O. 5 mm. Cu and 1 mm. Al. as filters; 30 cm. F.S.D., and having a portal of 10 x 15 cms. The intensity of Roentgen rays has been measured by (1) the Holzknecht radiometer with S. N. pastille; (2) the Iontoquantemeter of R.G. and S.; (3) Kuestner's gauzing instrument. We require 600 R to get the skin-erythema-dose or Seva-Sadan standard, which is almost the same as has been worked out by radiologists in Europe, e g., Holthusen (540 R), Holfelder (520 R), Wintz (600 R), and Meyer (617 R). According to the latest international "r" unit, 637. 6 r are required to obtain the skin-erythema-dose of the Seva-Sadan standard.

48. Experimental observations on the growth of plants under the influence of deeply penetrating X-rays.

SUBODH MITRA, Calcutta.

Experiments on flowering plants, such as cosmos and pansies, have been carried out. The plants were exposed to X-rays for 25 minutes—*i.e.*, about 1¼ of the skin-erythema dose of our Seva-Sadan standard. There is a marked retardation of growth in the plants under the influence of X-rays. In this series of experiments, a remarkable feature was that, not only were the plants Lilliputian in size, but the flowers were also very small as compared with the fully grown ones in the control series.

49. Studies in Blood Diastase.

CHARLES REID *and* BAMDEVA NARAYANA, Patna.

An attempt has been made to decide by experimental studies in dogs mainly whether the diastase in the circulating blood is or is not entirely a waste product, and to determine the main source of this enzyme. The influence of various procedures on the blood diastase has been studied, *e.g.*, anaesthetics, effect of meals (protein or carbohydrate mainly), injections of glucose, glycogen, starch, insulin, pancretectomy, etc. On the whole, the evidence that is available at the present stage in this investigation points to the diastase not being entirely a waste product on its way to excretion by the kidney, as injections of glucose, glycogen, insulin, and the partaking of meals cause a decrease in the amount of blood diastase. This would seem to indicate that diastase can be abstracted by the tissues for necessary tissue metabolism. Injections of starch, anaesthesia, lead to increases in the amount of circulating diastase.

MENTAL MEDICINE.

50. The position of Psychology in the Teaching of Medicine.

O. A. R. Berkeley-Hill, Ranchi.

The neglect of the Hippocratic principle of the unity of mind and body. Some results of this neglect on the theory and practice of medicine. The necessity for resuming the Hippocratic principle. A scheme for ensuring psychological medicine its proper place in medical curricula, in respect to (*i*) the study of alienation; (*ii*) the special branches of medicine and surgery; and (*iii*) general medical practice.

51. The Responsibility of Epileptics.

Capt. Aubin, Pondicherry.

This important question in medical jurisprudence has been studied from two different, and somewhat opposite, standpoints. On the one side some authors stress the 'attenuated responsibility', which does not defend society against the criminal action; on the other, some authors tend to lessen the responsibility of epileptics who, even when not in a crisis, consciously commit an interested and premeditated crime.

Two cases are quoted which show :—

(i) That in the paroxysmal and juxta-paroxysmal state, *i.e.*, in all periods during which the unlawful act is essentially the result of uncontrolled impulse, the irresponsibility is parallel to that in amnesia. From the psychological point of view, the amnesia is in the inverse ratio to the degree of consciousness. But those mentally confused, and the epileptic in particular, are not responsible, because they are unconscious (if there be no delirium). The degree of irresponsibility here is in proportion to the degree of amnesia.

(ii) In all other degrees of mental disorder, except insanity, that can be observed in cases of epilepsy, the degree of responsibility should be investigated as is done in cases of chronic-alcoholism, schizophrenia, confusional states, and the like where true lunacy is not present, and the psychical functions are only partially modified.

(iii) Hence, in true epileptic insanity, the responsibility is obviously nil.

52. Epidural Anaesthesic Injections in Mental Pathology.

Capt. Aubin, Pondicherry.

Professor Perrens of Bordeaux, inspired by an observation made by Claude and Biancani, has shown the therapeutic value of epidural anaesthesic injections in all mental afflictions in which one could observe an intense excitement of the genital organs, with or without clearly erotic or symbolic manifestations. On the contrary, erotomaniacs, amongst whom there is no physical excitement, are not affected by this method.

In four cases which we have observed,—1 maniac, 2 melancholics, 1 affected with mental debility showing signs of developing into precocious insanity—we have obtained rapid amelioration, and we emphasise the prognostic and diagnostic value which the method appears to have, especially in the case of the reticent class of patients so common in India. Trial of this treatment shows from the very first the importance of erotic excitement in the condition, the rapid improvement, of the patient under treatment and the pathological elements in its causation, the influence of which will tend to persist. Finally, one can judge to a certain extent beforehand the effect of marriage on the future mental state ot such patients.

MISCELLANEOUS.

53. The Causation of Cancer.

Ernest F. Neve, Kashmir.

After reviewing the evidence for heredity, and referring to the influence of diet, the author discusses briefly the parasitic theory, the question of cancer districts and houses, and of contagion. It is pointed out that Gye and Barnard's researches have produced evidence that some forms of malignant growth may possibly be due to a micro-organism. As an explanation of the general causation of different varieties of cancer, however, this evidence is quite inadequate.

The influence of irritation is emphasised, and the part played by the various rays of the spectrum, as also by chemical irritants, which are actual antiseptics. Under vital irritants, the effects of toxins resulting from faulty metabolism or even from micro-organisms, and also the influence of alterations in the balance of internal secretions is considered. The paper concludes with the following summary :—

1. The cause of cancer is irritation; physical, chemical, or vital.
2. This irritation releases tissue from ordinary growth control, and the latter thus acquires intensive, intrinsic powers of multiplication.
3. This growth control is to a large extent exercised by the endocrines, which influence the nutrition of growing cells.
4. The endocrine secretions can themselves be influenced by diet.
5. There is no definite evidence that there is a specific cancer parasite.

The difficulty in assuming the existence of multiple specific cancer parasites is insuperable. But the irritation of toxins produced by micro-organisms may sometimes act as an excitant.

54. The composition of Vesical Calculi.

B. N. Banerjee, Bangalore.

As a result of analysing a large number of stones, it has been observed that the surgeon's diagnosis of the composition of the stones was invariably wrong, being based on such physical characters as pigmentation and hardness. Stones are generally mixed in composition, rather than simple, and hence physical characters are exceedingly unreliable criteria. However, after comparing and examining nearly 200 stones, it has been found that if such physical characters as colour, hardness, half sections of the stone, surface layers, rings, and layers composing the stone, nature and number of the nuclei, be examined macroscopically and microscopically, then the composition of the stone can be foretold. This should be followed by an ignition test and a solubility test in hydrochloric acid, when the composition can be finally determined. These are simple and easy tests and require but very little time.

55. Does acute rheumatic arthritis affect Indians? Is unrecognised sub-acute rheumatic infection in childhood responsible for the mitral stenosis and congestive heart failure of young Indian adults?

H. STOTT, Lucknow.

1. Origin of interest in this question.
2. Former views that rheumatic fever did not exist in India, or affect Indians.
3. Acute articular rheumatic fever does affect young Indian adults.
4. The sub-acute rheumatic fibrosis of children. The frequency with which it terminates in mitral stenosis in England. The difficulty attending its diagnosis.
5. Unrecognized sub-acute rheumatic infection in childhood is the probable cause of mitral stenosis in young Indian adults.
6. Review of other possible causes of mitral stenosis:—
    - (*a*) congenital abnormality.
    - (*b*) degenerative disease.
    - (*c*) infections, (streptococcal, pneumococcal, scarlet fever, influenza, and syphilis).
7. Conclusion, with a note on world distribution.

56. Researches into the Aetiology of Urinary Lithiasis.

J. B. HANCE, Western India States Agency.

The paper deals with the results of chemical analysis of the blood and urine in cases of urinary lithiasis before and after treatment.

Section of Anthropology.

President:—THE REV. P. O. BODDING, M.A., F.A.S.B.

Presidential Address.

ON THE IMPORTANCE OF THE COLLECTION OF ANTHROPOLOGICAL MATERIAL.

When after much doubt and with a good deal of diffidence I agreed to accept the honour of presiding over the anthropological section of the Indian Science Congress this year, my principal reason for accepting was that I felt that this congress would give a unique opportunity of urging certain considerations on the Indian students of anthropology.

As we all know, the science of anthropology covers a vast field, that of humanity itself. We need to know ourselves and we want to know ourselves, not only as we are within our own limited boundaries, but also as part of the human race. We need to know ourselves, as we are to-day, our customs, our ways of living and conducting ourselves, our beliefs, what we believe, and how we practise our beliefs. We need to know all this, not only as it is, but also as it has become what it is, the development, the result of which has made it all what it is, the factors that have worked together to produce the present result, the more or less unconscious development that takes place everywhere and also the outstanding personal factors that from time to time make themselves felt.

Anthropology is as a science divided into two sections, physical and social anthropology. It is not for me here to say anything of the first; it has been dealt with at previous sessions of this Science Congress in an excellent way. I wish however, as in a parenthesis, to be permitted just to draw attention to the many problems that await solution through the works of the scholars who are occupied with this side, problems that cannot well be solved by unassisted individuals. I refer particularly to the system of physical measurements. A little has been done, but very much remains to be done to get this real foundation of the one section of anthropology securely laid. Might it not be a task for the Indian Science Congress to get this matter started by making an application to Government, to get people trained (especially medical men), to have the necessary implements made or purchased and to have the required forms and papers printed ?

What I wish to concentrate our attention on here to-day is the immensity of anthropological material lying in our midst, and partly untouched, and the pressing need of getting the material collected without delay. It is generally computed that between one fifth and one sixth of the human race lives in India, and this is very far from being a homogeneous mass. People living near each other are liable to intermix both physically and socially and to influence each other in several ways. In certain localities we may here in India find a nearly homogeneous or pure race of people; in others we have a large number of types that cannot possibly be descended from the same race.

Anthropological measurements are a sure guide, so far as they take us; but they are concerned with only one side: the assistance of philology and social anthropology is required to complete the investigations and find out the possible origin of all, and the ways by which all has reached us.

Our first task is to find out exactly what we have. Here there is one matter that I particularly wish to urge on all anthropological workers. Let us get an accurate, full and detailed description of any common, *i.e.* customary act or doing. This is the first consideration. Try to explain, if you can do so; it will be a help and a possible guide for those whose life work is the study of these matters. You may give suggestions of possible solutions of some of the many problems. What is of primary importance is to get an exact description. This will remain on record and will in the hands of the experts be what they will use and have to use, and what they will ultimately build their conclusions on.

It is unnecessary to point out that by furnishing such material Indian workers will be able to influence anthropological science to a considerable degree. A person may pooh pooh a theory, but he will have to reckon with facts, if he does not want to become a back number and in the long run be left out.

Permit me to urge this matter a little further on our Indian fellow-workers, both those who live in towns and, more particularly, those who live in the villages or are intimately connected with village life. There are so many things that are of daily occurrence, so much a matter of habit that we are scarcely conscious of them at all, and as likely as not, we do not deem them worthy of special or any notice. This may be the case, they may be of little importance; but just as likely they may be matters of real importance from an anthropological point of view. Why should such a matter be a commonly accepted and practised habit? Why not make a record of what is known? The result will surely be of interest, both to us and to those who come after us.

A custom may be a daily habit in one place, it may be unknown elsewhere. We may get a description of the same matter from different parts of the country. We may find that it is identical or that differences are met with in details. Then the question arises, what are the causes of the differences, are they individualistic and local or due to some extraneous influence? Further, we may find more or less the same things among peoples of different races, a fact opening out fresh problems that demand solution. We may hear of strange things met with in India and parallel ones met with in distant countries, where there seems to be no possibility of interaction or a common source. If we had the time I might as an example mention a curious custom observed by Santals and something very similar observed by old women, or anyhow some old women, in parts of Norway.

This recording serves another purpose. Nothing living remains unaltered. A custom, or whatever it may be, will with very few exceptions, develop, be somewhat altered or be gradually lost. More or less unconsciously the form will change in small details to suit the needs of those concerned; or else the attitude of the people may become changed. A custom may be changed or given up. There may be many causes for this. It is an observable fact that it so happens. It serves no purpose here to single out and praise or blame the possible agencies. We have to face the fact that customs for some reason or other change. Old, interesting, even essential matters may be entirely lost to our knowledge and understanding of certain sides of human life, if they are not preserved by being recorded.

I am here at a point that I wish particularly to lay stress on, because it shows the great need of recording what is to be found. To show the need, or in any case, the desirability of collecting and recording I shall ask you to let me tell you a little of what is happening and has been happening in an aboriginal people among whom I have been living for many years, viz., the Santals.

The Santals have some curious and very interesting traditions; it is at the present time not possible to make sure of their age and origin; in any case they must be old, and the way in which they have been kept alive goes far to prove age. The traditions commence with the creation of the world and especially of the first human pair, tell of human history, of the fire-rain that destroyed all mankind except one righteous pair, how humanity was divided and how the ancestors of the present day Santals wandered from place to place right up to now. A resumé of them are recited at least twice in the life of every Santal. The first time is, when they perform certain ceremonies that give a Santal the rights of a full member of Santal society. Without having been through this ceremony a Santal cannot be married and cannot be cremated when dead. The person concerned is at the time, so to say, given his or her place in living Santal history, the recited traditions in this case commencing with the parents of humanity and ending with the story of how the people came to their present abode and the birth of the youngster.

The next time is at the last funeral ceremonies, when the dead one, so to say, is formally sent out of this world and given over to those on the other side, especially our first parents. I have mentioned this just to show that in any case for some very considerable time the traditions must have been kept alive among the people. They have been kept by their *gurus* who have been officiating as reciters at social ceremonies. It is a fact, that these *gurus* are becoming few and seem to be disappearing. The traditions have fortunately been recorded.

In these traditions there is one very peculiar matter to which I wish to draw attention. They mention that at a particular time when the ancestors had moved away from a country called Champa (possibly the country on the western border of the present Chota Nagpur plateau), they stopped at a certain place (possibly near the sources of the Damuda river). Here they were deliberating, whether for twelve days or for twelve years they declare they cannot say any longer. The result was that the ancestors decided to give up certain customs in connection with the principal events of a Santal's life and to introduce new ones (the purification ceremonies in connection with birth—or namegiving—and the giving of full social rights to every individual, further ceremonies in connection with marriage and death). Before this event they buried their dead ones, and from this time they commenced to cremate.

The new ceremonies and customs were adopted generally under the influence of Hinduism, a matter expressly admitted in their traditions. It is significant that practically all the names for relationship brought about by marriage are of Aryan origin. This naturally does not mean that the ancestors of the Santals had no marriage arrangements previous to this time, but the new arrangements may have introduced certain new special relationships, not previously recognized. There are in connection with their present very elaborate marriage ceremonies a few expressions that may constitute a remnant of former customs and may possibly point to a method of marriage by capture (as, *e.g.*, some money is paid " to put down on, *i.e.*, to cover the tracks, " as it is styled). This has, in fact, been done away with and instead of having a proceeding that might establish enmity the present marriage customs are intended to bring about exactly the opposite. The common Santal name for marriage is *bapla.* I have no doubt that this is a reciprocal form of *bala*, a word, as you will know, comes from Sanskrit. A marriage to the present day Santal consequently means mutual strengthening, namely of the two families. Marriage is, when regular, arranged between the families, the two most concerned not being permitted to have any intercourse before marriage ; now-a-days they are permitted just to see one another at a distance and on this foundation to declare whether they are willing to be married or not.

It is unnecessary to point out what a difference this presupposes between the present and the probable former custom. The parents of the married couple speak of each other as *balaṅ hor̥*, lit. my strength's person, and speaking together to each other they use the inclusive plural (we, you and I or we), even when referring to only one individual meaning either the speaker or the person addressed.

We have here an example of how one people is influenced by another, resulting in deliberate action. Of what value to science would it not have been if the previous customs of the Santals or rather of their ancestors had been recorded and known. But there was no one to record them. We can only conjecture. Knowing the real Hindu customs and the present day Santal ones in connection with marriage we may draw certain conclusions, but can never ascertain the previous reality.

We may not have anything absolutely identical at the present time; but a change is taking place among many of the Indian races, more especially among the aboriginal ones, sometimes unconsciously, brought about by constant contact with the more civilized peoples, sometimes consciously and willed, in analogy on a smaller scale with what happened, as just told, with the ancestors of the Santals.

On the other hand, the great communities may in certain ways be influenced by the smaller ones. It is a great task calling on Indian research workers to find out, so far as it is possible, what may have gradually crept in from outside and been assimilated, or what are the customs, etc., original and adopted ones, among the many peoples or tribes that have in the course of time established themselves as adherents of one or the other of the great communities. The first step towards solving these problems is to get true and faithful, detailed statements of ascertainable facts.

The smaller communities are, to revert for a moment to what was said above, on their side constantly influenced by the surrounding peoples, in certain cases unconsciously, in other cases knowingly.

Well-known examples might be mentioned. The late Sir Herbert Risley in his introductory remarks to his work "The Tribes and Castes of Bengal" refers to some instances. I have been in contact with some of the cases mentioned, *e.g.*, with those who now call themselves Rajbongshis in western Assam, further with the Pulias in north-eastern Bengal, the Paharias and the Bhuyas in the Santal Parganas. In all these cases we have non-Hindu communities deliberately attempting to pass themselves off as Hindus, strangely enough frequently as descendants of Rajputs. In the two last named cases we have so-called semi-Hinduized tribes who aspire to a higher position in the caste system.

In all cases it would be of great value to anthropological science to be able to follow this development, and there is no other safe way than to get records of what there is and what is coming on, of what the changing customs are, with all details. If it is not done, we will be without knowledge of much.

To mention one more example, viz., the present state of the Santals. It is an undoubted fact that Hinduism is gradually influencing the people. At the Hindu festivals the Santals are participating spectators and are responsible for most of the noise; they are not properly worshippers, but participators. Individuals have commenced to worship Kali; in times of scarcity some Santals (even some of their leaders) have in their own special way worshipped Mahadeb, *i.e.*, Shiva. Under Hindu influence many, especially Santals of the well-to-do class, have commenced to marry their children while quite small, while the original custom was and now still generally is for marriage to take place when the parties are grown well into maturity.

Under foreign influence the Santals are gradually, it seems, developing into a kind of agricultural caste, while they have originally been willing and able to do all kinds of work. Many customs are gradually creeping in, more or less unconsciously. I might mention a good many instances that have come under my observation. It is not, however, the place to enter on details here. When I have said as much as I have, it is to point out that if the present state is not recorded, no one will in time to come be able to have any certain knowledge of customs, etc., that have been, what has been lost or what has been newly adopted. What is the case with the Santals will be the same with a large number of peoples living in India. While there is time, let us get detailed records.

You will permit one who has had some experience of this kind of work to offer a word of advice. My experience has taught me to be very careful, that is the way to get the facts, not what oneself may start thinking it is from theories gathered from elsewhere. These may be helpful; but it is quite astonishing how easily one may be led astray. Testing and re-testing statements is absolutely essential, and here a sound knowledge of the language is necessary.

There are two things more I wish to mention in this connection. First concerning the study of the language, if it is not the language of the recorder. It is quite astonishing what a close study of the language may reveal. It will not generally give dates, but it will give points to understand development and foreign influence; take as an example what was mentioned above about the present-day Santal names for marriage and relationships brought about by this. Or take the names of implements, and domesticated animals; it means something when it is known that the word used cannot possibly be one originally belonging to the people. Or, another consideration, the language will in many cases be a direct help to understand the mentality of a people and to show in what direction anthropological investigations might be fruitfully turned.

The other subject I would like to draw particular attention to is the folktales. These are found among all peoples. It is quite unnecessary to point out to you, who are assembled here, the value these have from an anthropological point of view. The folktales contain matter that touches most sides of the cultural life and the beliefs of those who have them. From some points of view they may be quite invaluable. They may be original, they may be borrowed. Even if borrowed, except perhaps in first-hand borrowing, they will in details reflect the mental qualities of the borrowers, and more so the longer the story has been told. In this connection I shall mention only one matter, the reason why I have mentioned this at all here. I am under the impression that folktales are being forgotten at the present time, not only among the more civilized peoples, but everywhere. I know that this is the case among a people like the Santals. I have during my life among them collected a very large number of folktales. Some of these stories are not heard any longer. Those who knew them are dead, and they did not succeed in transmitting the stories to others, because the younger generation did not care to learn. As the years pass, most, I am afraid, will be lost, and my impression is that what is lost is the best part of the folktales.

As a supplement to the folktales we have the reminiscences of old people, their own or those they may have heard from their parents and grandparents. There is nothing that is without interest; even if not published at present, if only written down and kept in safe places, later generations will use it and be glad to have it. In Europe and elsewhere the universities and learned societies have chairs and sections for the study of folklore; what they have to work with is partly what is being collected everywhere among the peoples. A little is being done in India, why not try to get a good deal more done?

Here I bring my remarks to a conclusion. There is much more I should have wished to touch on, *e.g.*, to mention only one matter, all what is living and found in the women's section of society, of the greatest interest and importance and really so little known, also undergoing change and development, much is still to be had now that in time will not be obtainable any more, perhaps also matters that this conservative section of society has preserved and that are not heard of any more among the men.

We have all experience of how matters may at the present-day change, to a very large extent due to the facilities of moving from place to place. There is no place in India so remote or difficult of access that outside influence will not make itself felt. I feel sure, it would not be possible to happen any more what once happened to me in a village among the Santal hills. The headman came to me and asked me to go from house to house and let people see me, because there were several old women who had never seen a white face. People travel ; for a few annas one may get far away from one's home. Even if some always stay at home, people from outside will reach them. Inevitably, consciously or unconsciously people will be influenced by what is seen or heard, and some change will be the result.

It might have been expected of me to give a resumé of the present state of anthropology. I had to choose, and this would have prevented me from saying what has been my one object, viz., to urge on you and on all who take an interest in these matters, to use the opportunities we have for collecting and recording anthropological material, before it is lost. This will help us to know ourselves and it will furnish scholars all over the world with what they will and must use in their work. We have in India just as much, if not more than there is in other parts of the world. May the materials be collected before it is too late.

We have in India certain learned societies and certain public libraries that I am sure would be glad to receive all materials, if not for publication at present, then at least for keeping all in deposit. It might be desirable for anthropological science to get an institution for collecting. May we get it.

Section of Anthropology.

Abstracts.

1. Religion and Kingship in ancient times.

J. C. De, Colombo.

It is certain that Hindu supremacy was at least reasserted and the links of the chain of cultural comradeship which bind Hindus all over India even now were forged during the Gupta Period of North Indian History, to which we propose to confine our remarks. Inscriptions, coins, and contemporary accounts of foreigners furnish us with the necessary data. Knowledge derived from Hindu sources can be readily verified by that from Buddhistic ones.

The social position of the Hindu citizen depended on the caste to which he belonged. Candalas who stood probably on the lowest rung of the ladder lived "apart from others," and were "held to be wicked men." When they "entered the gate of a city or a market place" they had to "strike a piece of wood to make themselves known, so that men should avoid them." On the other hand, the hereditary Brahmana priest respected by his king, sanctified by a culture which placed him in the forefront, and edified by the ideal of a virtuous life which was persistently kept before him, occupied the first place in the social hierarchy. This high social status reacted on the political, and there is evidence to prove that he became undoubtedly a potent factor in the political organisation of the time.

Brahmanism, however, did not claim the allegiance of all. Buddhism and Jainism existed side by side with it. Besides the followers of these three principal religions there were the followers of Devadatta who "made offerings to the three previous Buddhas, but not to Śākyamuni Buddha." "Ninety-six heretical sects" other than the Devadattan are also mentioned. The attitude of the Hindu king towards the priests and congregations of the other religions is worthy of attention. There are some instances of persecution. The Brāhmanas are said to have cut down the tree of the dantakashtha of the Buddha, and quarrelled with the Śramanas over the shadow cast on their temple by a Buddhist Vihāra. The Buddhists regarded the Brāhmanas as followers of "contrary doctrines" and "malbelievers." At least one story is related by a foreigner which shows that attempt was made by the Buddhists to create a feeling of animosity against Hindu priests. Saśānka's attempts to exterminate Buddhists to efface the foot-prints of the Buddha, to throw away a stone regarded as extremely sacred by the Buddhists into the Ganges, and to cut down the Bodhi tree show that the Buddhists were fully justified in calling him "the enemy and oppressor of Buddhism." The persecuting meaures of Mihirakula and the performance of Aśvamedha Sacrifices also point to the same direction. But one must remember that the Chinese evidence pro-Buddhist in outlook, Mihirakula was unusually hard-hearted and cruel, and probably started his career as a Buddhist king who never assimilated the Hindu culture of his day. The identification of Mihirakula with Caturmukha Kalki is again very doubtful.

Moreover, the positive evidence leads us to conclude that the general attitude of the Hindu king towards the non-Brahmanical priests and congregations was one of sympathy and toleration. Images of Hindu gods were carried on cars side by side with those of the Buddhas in Buddhist religious procession. Brahmana priests used to nurse sick

Buddhist pilgrims, Brahmanical temples were frequented by "all religious persons," the Rājadhirāja and Rishi Chandragupta II specially devoted to Vishnu employed Buddhist officers of state and ensured the prosperous continuance of many sanghārāmas. One of his governors supplied "food with" his "own hands" to the Buddhist priests "and showed great respect to them," and one of his generals granted a village and a large sum of money to the Buddhist monk of Sānci. The Valabhi grants show that the princes considered that "the increase of the spiritual merit of parents and attainment of blessings in this life and the life hereafter to the utmost limit of the grantee's desires" could be achieved by grants to Brahmanas for agnihotra, atithi and the three mahayajnas as well as by those for the upkeep of Vihāras, feeding of bhikshus, and supply of perfume, incense and oil for lamps placed before images of Buddhas. In at least one Buddhist grant ślokas from the Hindu epic—the Mahābhārata—were quoted. Lastly every facility was granted by the king to his non-Bramanical subjects to record their religious grants publicly on stone.

2. The disposal of the dead in India.

H. C. CHAKLADAR, Calcutta.

Cremation which is associated with the brachycephalic Aryan speaking peoples in Europe, is the predominant form of disposal in early Vedic times, probably because the round-headed speakers of Aryan, entered India earlier than the long-heads who adopted their culture. Burial also was in vogue, and besides, exposure on an elevated platform as among the Iranians; Vedic texts show clearly that people with Iranian affinities lived side by side with the Vedic Aryans. Burial of the ashes in an urn was widely prevalent (cf. disposal of Buddha's ashes). Burning of the wife with the dead husband was perhaps in use in pre-Vedic times, but was revived afterwards. The Epics speak of earth-burial as the custom prevalent among the non-Aryans (Rākshasas), but children of mixed parentage appear to have adopted the Aryan custom. Traces of both burial and cremation are found at Mohenjo Daro. Exposure of the dead was prevalent among the Lichchhavis who were a powerful people in Buddha's time. Cist-burial in Southern India in pre-historic times.

Burial is still prevalent among some Hindu castes; some sects of highly-respected ascetics—Sannyāsins and Vaishnavas—bury the dead and besides, among all castes, children of a certain age are buried. In all these cases it is, no doubt, a survival of an ancient, widely prevalent culture. Jungle tribes are in some cases adopting Hindu customs, but generally speaking, they bury the dead. Some (like the Nagas) expose the dead on a raised platform. Some hang the dead bodies from trees (cf. Mahābhārata, Book IV). Preservation of the dead body among some peoples for a time before final disposal (cf. Ramāyana, Book II).

3. The way to the pantheon.

SATINDRA NARAYAN ROY, Cuttack.

The paths that lead to the Hindu pantheon are full of minor gods and goddesses. We shall deal with some incorporeal deities with special reference to Orissa. There is a tradition that the presiding goddesses of old tanks used to loan out utensils for the asking.

People believed that half-divine beings inspired men with knowledge and skill. Men used to bury a boy with their treasures in an underground vault. The spirit of the boy guarded and increased the treasures and made them over to the proper persons for whom they were consigned.

A section of the Saura tribe and the Kewats trace their descent from the nymphs of the Vaitarini and the Mahanadi respectively.

Small-pox and Cholera are said to be caused by incorporeal spirits called Yoginis, attendants of Chandi. The earth-goddess is now worshipped by cultivators thrice in the year. The sea, according to tradition, once swallowed up foreign invaders and formed the Chilka lake by flooding a part of the Puri District.

4. Some Osas or occasional worships of Orissa.

SATINDRA NARAYAN ROY, Cuttack.

The Osas are occasional worships.

The moon is worshipped in Chanda Osa by women who get still-born children.

The Khudrukuni or Bhalkuni Osa is held on Saturdays in the month of Bhadra in honour of goddess Mangalā, an incorporeal deity without special form who likes to do good if worshipped.

Bata Osa is held in the month of Agrahayan in a secluded part of the village common for getting good and healthy children.

Lakshmi Osa is held in the month of Agrahayan in honour of Lakshmi, the goddess of plenty.

Savitri Osa is in honour of Savitri (wife of Satyaban) who revived her husband by her chaste devotion.

Ganda Kuchia Osa is held in the rainy season. Rice cakes are offered to fresh water shells and stinging fishes, so that they may not harm men, engaged in cultivation.

Kangi-am̃ala Osa is done by Brahmin widows in honour of boiled rice steeped in water, which is a favourite food of the people of Orissa.

Bara Osa held in the month of Kartic is peculiar to the district of Cuttack. It is in honour of Dhabaleswar Siva.

5. The Besthas of Nellore.

S. T. MOSES, Calicut.

Introduction. The Caste, its Names and Divisions. Traditional Origin. Occupations, Fishing Gear. Ceremonies and Beliefs connected with Nets and Fishing. Puberty, Marriage and Childbirth customs. Adultery and Divorce. Feed. Caste Organisation. Religion. Habitations. General Appearance, Cranial and Nasal Measurements. Present Condition and Social Status.

6. The Korwas and their Country.

D. N. MAJUMDAR, Lucknow.

The author gives a brief description of the Korwa settlements in Perganah Dudhi, District Mirzapur, U.P. The physical features of the Perganah have determined to some extent the social and material life of the people. A short description of the flora and fauna has been attempted and the influence of environmental factors on the life of the people depicted. A summary of fifty anthropometric measurements is given and the ethnical affinity of the Korwas discussed. The measurements were taken by the author while he was deputed by the University of Lucknow to study first-hand the social and economic organisation of the aboriginal tribes inhabiting the extreme south of the Mirzapur District. A brief description of dress, shelter, articles of domestic use, utensils, ornaments and methods of food-quest is also given.

7. Social Organisation amongst the Korwas.

D. N. Majumdar, Lucknow.

The different forms of association amongst the Korwas are described. The function of the tribal council, the authority of the council, the duties of the council, the various disputes which the council has to arbitrate, the constitution of the council, social taboos, the origin of a rigid endogamy amongst the Korwas which has led to in breeding, influence of witches, sorcerors, and intermediaries between man and spirits, viz. bhagats, ojhas, patharis, and baigas, the rule of residence and the laws of inheritance, etc., discussed. An interesting case of tribal offence and how it was decided by the council is briefly described.

8. The cycle of life amongst the Korwas.

D. N. Majumdar, Lucknow.

The author describes in detail, all beliefs and rites associated with the principal events of human life from birth to death. Man at every stage of his existence from savagery to civilisation has attempted to solve the mystery of life, and at every stage of his progress, he has developed a system of beliefs and rites which has offered a solution to the problems he was faced with. These beliefs and rites have no doubt undergone considerable change with greater complexity and higher expectation of life, with every change of man's physical and social environment, yet much of these have come to stay due to the insoluble character of the problems and the absence of any agreement between the metaphysical speculations of different cultures. To the primitive man, however, the problems were not so intricate as they are to us and so we find practically the same conceptions regarding birth, marriage, and death amongst people of ruder culture in all parts of the globe. This uniformity of beliefs is a product of a particular stage of culture associated with tribal life everywhere. Primitive man conceived society as composed of constantly recurring units which left little scope to invent any complex system of metaphysics.

9. A statistical study of certain anthropometric measurements from Sweden.

P. C. Mahalanobis, Calcutta.

Contains a biometric analysis of the measurements of 17 characters for 46,983 individuals. The Co-efficient of Divergence previously described by the author has been shown to give much more satisfactory results than the Pearsonian Co-efficient of Racial Likeness. A new Co-efficient of Familial Differentiation has also been used extensively, and several other theoretical co-efficients have been compared. On the purely anthropological side the homogeneity of the Swedish people, and the question of its migrations have been discussed in detail.

10. Tattooing in Orissa.

Satindra Narayan Roy, Cuttack.

Tattooing is a very ancient decoration. The popular beliefs and superstitions that have gathered round it are numerous and highly complicated.

Women of all castes put on tattoo marks. The aborigins also put them on. They have come to be regarded as the distinguishing mark of Hinduism. This is why the Mahomedans do not put them on.

Tattooing was primarily intended as a decoration. References to it as decoration can be found in the ploughman's songs and other rural poetry.

Religious symbols are often used as designs. They are a reminder to the person concerned not to go into the ways of sin. They rouse holy thoughts at the moment of death and are protection against the tortures of hell.

Even secular designs would afford protection against the messengers of Yama, who are enjoined to inflict punishments on a whole skin and not on a mutilated body.

Some astrological signs of the palm as well as the traditional mode of describing a woman's body in poetry have contributed to the formation of tattoo-designs.

Tattooing is a sign of adolescence and not of puberty.

A few select designs are attached to this paper.

11. On an ancient aetiological myth about the periodical leaflessness of the silk-cotton tree.

S. C. Mitra, Calcutta.

The silk-cotton tree (*Bombax malabaricum*) annually sheds its leaves and assumes a bare and denuded appearance. The most observant among the ancient Aryans was struck by this extraordinary leaflessness of this tree and, being unable to hit upon the true cause of this phenomenon, invented a myth to account for it.

In this paper, Prof. Sarat Chandra Mitra has published the results of his study of this myth and has come to the conclusion that, by inventing it, the ancient Indian myth-maker has served the undermentioned two-fold purpose :—

(1) He has accounted for the origin of the periodical leaflessness and denuded appearance of the silk-cotton tree.

(2) He has also taught the grand moral lesson that "Pride goeth before destruction, and haughtiness before a fall" and that no one should, therefore, indulge in bragging and boasting.

12. A note on the prevalence of cannibalism among the Bīrhors of Chota Nagpore.

S. C. Mitra, Calcutta.

In Indian mythology and folklore, certain super-human and cannibalistic beings figure largely. They are known under the name of *Rākshasas* which word means "*the harmer or destroyer*". They are of the ogre-vampire type. They ensnare human beings and devour them.

The belief about the existence of these cannibalistic Rākshasas has been current in India from the most ancient times. Some scholars are of opinion that these cannibalistic beings are the prototypes of the early Dravidian antagonists of the Aryan Hindus.

In this paper, Prof. Sarat Chandra Mitra has shown that some color of plausibility is lent to the foregoing opinion by the fact that there is, at least, one Dravidian tribe, namely the Bīrhors, now living in Chota Nagpore, whose folklore has disclosed to us the fact that, in some far-off time, they practised cannibalism, that is to say, they used to feed upon the flesh of human beings.

13. On the parallelism between the Mahābhārata legend about the disrobing of Draupadi and a tradition recorded in the Japanese Kāmākurāshi.

S. C. Mitra, Calcutta.

In this paper, Prof. Sarat Chandra Mitra has compared the Mahābhārata legend about the disrobing of Draupadi and a tradition recorded in the Japanese annals entitled the Kāmākurāshi. In the Indian legend, Yudhisthir, the husband of the heroine Draupadi, staked her as a wager at a game of dice which his opponent Duryodhana wins. Having won her, the winner attempted to disrobe her. Being placed in this disgraceful predicament, she prayed to the god Hari who saved her from the shame of standing nude before the assembled players by making the *sari* unending.

In the Japanese tradition the great Prince Tairā-no Tokyori plays at chess with his wife and after playing several games made the stipulation with her that whosoever would lose the next game would have to stand nude on the chess-board. She agreed to the stipulation, but lost the next game. According to the stipulation she was to have stood stark naked on the chess-board. So she prayed to the god Jizo to save her from the disgrace. In response to her appeal, the god came and taking her place on the chess-board, changed himself into a woman.

Prof. S. C. Mitra thinks that this parallelism is due to the "Psychic Unity" of primitive races.

14. Totemism and Origin of Clans.

D. N. MAJUMDAR, Lucknow.

A study of the origin of totem clans amongst the tribal population of the Chota Nagpur Plateau explains the source of totemic organisations and all totem taboos. The author has attempted to explain the theories of totemism on the basis of these traditions and has been led to the conclusion that the spirit of totemism is to be sought not in a religious attitude to totemic objects or emblems, not in a gradual process of postulating in totems the higher powers or spirits who rule or influence the destiny of the savage, nor in the social or economic necessity of preserving the species of edible products of the vegetable and animal kingdom but in a simple adjustment of social order which could bring about a sympathetic relation between man and his environment. Such a relation subserves the needs of human adjustment to the habitual, and might be the result of an agelong process of trial and error or of an accidental discovery in the course of human migrations occasioned by the exigency of unfavourable conditions in the parent zones.

15. Notes on some Mundari legends and customs connected with the origin of the names of Ranchi and of some of its suburbs.

S. C. MITRA, Calcutta.

In this paper, Prof. Sarat Chandra Mitra has set forth the legend which is narrated about the origin of the place-name Ranchi. This legend goes on to say that, once upon a time, a Munda ploughman was ploughing some field near the present Ranchi Lake. Feeling very thirsty, he stuck his bullock-goading bamboo-stick (called *Ālāchi* in Mundari) and went to quench his thirst. In the press of his work, he forgot all about his "*Ālāchi*" and returned home in the evening. In course of time, this bamboo-stick struck root and grew up into a fine bamboo-clump. The Munda cultivators settled about this bamboo-clump. This new settlement came to be known as "*Ālāchi*" which, in course of time, was pronounced as "*Lāchi*" and then as "*Rāchi*" or "*Rānchi.*"

The place-name Thārpākhnā has been derived from some "Standing-Stone" memorials which stood or still stand in this locality. The word *Thārpākhnā*, in Hindi, means "Standing-Stones." Its Mundari synonym is *Bid-diri* which means "Upright stone-slabs." These "standing-stones" are memorials set up by the Mundas in memory of (1) their tribesmen killed in tribal fights, (2) of those killed by tiger, and (3) of those who are the patriarchs of their tribe.

The name "Hind-piri" means "*the upland on which the 'Hind' or 'the Umbrella Festival' used to be celebrated in former times.*"

Then again, the place-name Doranda means "*the place where men drank water and, then, sang.*"

16. On the cosmological myth of the Bīrhors, and its Santali and American Indian parallels.

S. C. Mitra, Calcutta.

A cosmological or creation myth is a legend or story which accounts for the creation of the world, for the existence of the universe, for the origin of mankind, beasts, birds, and other animals, and of trees and plants, and for the cause of the distinction of race and species, and so forth.

In this paper, Prof. Sarat Chandra Mitra has dealt with the cosmological myth of the Bīrhors of Chota Nagpore, and has shown its similarity to the creation-myth of the Santals of the Santal Perganas. He thinks that this similarity is due to the facts (*a*) that both the Bīrhors and the Santals are members of the Dravidian race, (*b*) that both these peoples have similar modes of living, similar ways of thought, and similar religious beliefs, (*c*) that they speak closely allied languages, and (*d*) that both have their habitat in Chota Nagpore and the Santal Perganas, which are in close proximity to each other. He further thinks that either the Bīrhors borrowed the myth from the Santals, or the latter borrowed it from the former.

Prof. Sarat Chandra Mitra has further shown in this paper that some of the main ideas embodied in the Bīrhor and the Santali myths are also to be found in the cosmogonic legends of the Huron, the Algonkin and the Californian Indians of North America, as also in those of the Orang Dusuns of British North Borneo, and of the Ahoms of Assam. He thinks that, in these cases, the similarity is due to the "Psychic Unity" of these widely-separated peoples.

17. On a Bengali myth about the betel-creeper.

S. C. Mitra, Calcutta.

The betel-creeper (*Piper betle,* Linn.) is well-known throughout India under the name of "*Pān.*" In some parts of Bengal, the following myth is narrated to account for the origin of this name.

Once upon a time, a prince, while out hunting, suffered from excruciating thirst, and became almost dead. An ascetic gave him the leaves of a creeper to chew. By chewing these leaves and sucking the juice thereof, the former was cured of his unquenchable thirst. Being thus revived, he returned to his kingdom, had this creeper cultivated, and informed his subjects that its name was "*Prān*" or "*Life.*" But his subjects corrupted this name into "*Pān*" under which name the betel-creeper is known to the present day.

In this paper, Prof. Sarat Chandra Mitra has shown that by analysing the foregoing myth, it is found that the undermentioned three moral lessons have been inculcated by it :—

(1) That all acts of heartlessness must be rightly and properly punished.
(2) That mercy should be shown to the wrong-doer after he has been properly punished.
(3) That gratitude should be expressed by a person for all acts of benevolence done to him.

18. Tibetan Folklore from Kalimpong in the District of Darjeeling in the Eastern Himalayas.

S. C. MITRA, Calcutta.

In this paper, Prof. Sarat Chandra Mitra has published the texts, with English translations and notes, of some Tibetan folk-songs, riddles, and proverbs which he collected at Kalimpong in the District of Darjeeling in the Eastern Himalayas during his four month's stay there from March to June 1928. He has shown that the characteristic of Tibetan folksongs is their amatory tone.

He has also given some ethnographic notes on the Tibetans and their mode of life and food. He has also shown that the Tibetans claim to be descended from a monkey and have therefore anticipated Darwin by many centuries.

19. The 'Magical Conflict' in Santali, Bengali, and Ao Naga Folklore.

S. C. MITRA, Calcutta.

There are some cumulative folktales which belong to what Mr. Baring-Gould calls popular fictions of "The Magical-Conflict Root." In folktales of this cycle, two or more persons possessed of nearly equal magical powers of metamorphosing themselves into whatever shapes they like, engage themselves in a life-and-death struggle. Folktales of this group are current among various races of people inhabiting tracts of countries separated from each other by wide oceans and high mountain-ridges. We can account for the universal prevalence of this cycle of folktales by the widely-spread popular belief that men are capable of acquiring magical powers whereby they can metamorphose themselves into whatever forms they please. Folktales of this cycle have been collected from all parts of the world and studied by Mr. W. A. Clouston; and the results of his study thereof were published in 1887 in the first volume of his *Popular Tales and Fictions.*

In this paper, Prof. Sarat Chandra Mitra has summarized and discussed one Santali, two Bengali, one Ao Naga and one Thado folktales of the aforedescribed "Magical-Conflict Root" which have been discovered since 1887, and which are, therefore, new additions to our knowledge of this subject.

20. Some village deities in the neighbourhood of Khurda.

KALIPADA MITRA, Monghyr.

Temple of deities Varunai and Karunai in the Varunai hills about 2 miles from Khurda (Puri district). Four armed deities, now two arms lost. Vehicle, lion. Lion is the vehicle of Simhavahini Hindu goddess, and of vajraya deities Simhanada, etc. The goddesses unknown alike to Hindu and Vajrayana panthions. In the settlement papers of 1841 in the Collectorate Record room of Cuttack is mentioned a gramadevati Varunai Thakurani. Many such Thakuranis are Vajrayana deities. Probably Varunai is a Vajrayana deity. Another goddess Jangala Bhuasuni—having no image is represented by vermilion smeared rude stone guarding the pathway to the Pandavaghara hills. Her character. Temple of Hata Keśvara. Belief of barren women getting children by eating anything they get by a search in the dark in the reservoir.

21. Goddess Bhaṭṭārikā.

KALIPADA MITRA *and* GHANASHYAM DAS, Monghyr.

Temple of goddess Bhaṭṭārikā situated on the Mahanadi river in Baramba State (Orissa). Bhaṭṭārikā most probably a Vajrayana deity (references given to the Sādhanamālā) in origin, round whom clustered many animistic practices of the aborigines—fusion of two cults—Baḍambā equivalent to Bṛhadambā—the Great Mother—the state named after her—the temple described—Malīs, officiating priests and not Brahmans—autumnal puja held with ceremony—oracle of the inspired *kalsi*—legend indicating relic of human sacrifice—stone throwing at the temple by invisible agency—intolerance of shrines—other examples given—the Śakti worship—references to Whitehead and Elmore.

22. On the conventional methods of punishment and disgrace in folklore, *Riding the Ass.*

KALIPADA MITRA, Monghyr.

The delinquent, who was guilty of an offence for which death would be too heavy a punishment, was forced to mount an ass and expelled from the city. Usually he was placed on the ass, face towards tail, which often he had to hold in his hand in place of bridle. He was paraded round the city, being led from street to street and from square to square, where he received whipping. Drums were beaten as he was led in procession to give wide publicity to the punishment. Many insignia of shame attended him on the occasion, e.g., his head was shaved off (with some locks left indicating slavery), face blackened (or one cheek painted white, the other black), cow dung water or sour curds poured on him. Compared with punishment accorded to the thief in Pali literature. References:—Sûkasaptati, stories of Pārśvanatha, Vetāla-Pañcaviṃsáti, Tibetan Tales, Elliott, Ocean of story, Bengali literature, Jeliapara Song, Bakargunj scene, and Saran Records. Significance of shaving explained.

23. On a type of Sedentary game prevalent in the Punjab.

HEM CH. DAS-GUPTA, Calcutta.

This is a type of tiger-play found existing in the district of Shahpur in the Punjab. The game has been described and its peculiarity pointed out.

Section of Psychology.

President :—Prof. A. S. WOODBURNE, M.A., B.D., Ph.D.

Presidential Address.

THE CONTRIBUTION OF PSYCHOLOGY TO ANTHROPOLOGY.

It is the province of psychology to study the mental life scientifically. Its sphere is as wide as the expressions that characterise mental activity. Being a comparatively youthful science there is much material within its legitimate scope with which it has scarcely begun to deal. Only a beginning has been made, for example, in investigating those fundamental tendencies which find expression in human social behaviour. There can be no doubt of the great importance of the influence of the social environment as a determinant of human behaviour. In a thousand ways the individual is moulded, directed and compelled by the collective mind in which he shares. His beliefs and his doubts, his joys and his sorrows, his attitudes and his prejudices, his habits of thought and habits of action are much more largely parts of his social inheritance than they are individual characteristics and achievements.

The role of society in the determination of mental activity is increasingly understood and appreciated through the use of the genetic method in psychology. The hypothesis of evolution is quite as fruitful in accounting for social structures and functions as in biological matters. That means that the study of the phenomena of primitive societies possesses a value for the psychological interpretation of the more complexly articulated forms of civilized society. Such social sciences as ethics, economics and politics have gained immensely by the application of psychological methods to the problems with which they are concerned. We can understand as would otherwise be impossible how institutions, customs and beliefs have come to function as attempts to satisfy the felt needs of society.

It is in this connection that the sciences of psychology and anthropology are able to co-operate so effectively. They can combine to give a description and interpretation of primitive culture with its medley of things magical and religious. Anthropology has been especially concerned hitherto with such matters, and the anthropologist aims to be as objective as possible in his inquiries. An investigator who would give a fair and reliable account of the institutions, ceremonials or mental traits of any group must strive to divest himself, as completely as possible, of the thoughts and feelings characteristic of the social mind in which he shares. He must adapt himself, as far as possible, to the mentality of the people under investigation. It is a very easy mistake for an anthropologist to carry his own group motives and attitudes into the interpretation of the beliefs and activities of more primitive peoples. And it is only by disciplining himself most rigorously that he can overcome the temptation. The proper mental attitude for the social anthropologist is what the artists call 'empathy'—an entering into the feelings and impulses of others. He must try to put himself psychologically in their situations, and imagine how they feel and why they act as they do.

The cultivation of this attitude of sympathetic participation is the more necessary because in so many cases data are lacking for a historical account of the antecedents of existing practices. Anthropological investigators of the institutions and behaviour of particular communities have to take things as they find them. Sometimes that which they find is an institution or a folkway that has been well established for an apparently long time. But the student of human affairs is not satisfied. He desires to pry into the reasons why behaviour has taken a certain pattern or why an institution has assumed a particular form.. That is not always an easy task, for primitive peoples do not usually possess a well developed historical sense. Such a mentality is the outcome of long and laborious processes of reflection. One of the sources to which the observer turns is the mythology. Is there anything here that will throw any light on the origin of established customs or institutions ? Frequently there is, and yet it is clouded beneath a veil of symbolism, so that there remains the prior task of unravelling the significance of symbols. There is abundant opportunity for some one to make a careful study of the psychology of symbolism, a study which will at once take from and contribute to anthropology as it is concerned with primitive culture.

Another instrument for the better understanding of primitive culture is the comparative method, which is to a large extent psychological. We find certain types of behaviour characterising a people in particular situations. On the surface we can find no clue to an understanding of the behaviour. There is no logical association apparent between the situation and the group response. If we ask the people themselves the reason for their behaviour, their only available explanation is in terms of the folkway. Their forefathers from time immemorial have so responded to this type of situation, and that reason is regarded as quite sufficient for carrying on in the same way. That there ever was a beginning to this way of behaving has never occurred to them, much less that there was a time when these remote ancestors behaved differently. The problem of origins resolves itself into a problem of motives. Lacking historical data, the anthropologist tries to ascertain what were the needs for which satisfaction was sought in this way, what were the motives that drove men to adopt this mode of social action. It so happens that sometimes he finds another group or the records of a group in an earlier stage of what appears to be the same social tendency, a group which has adopted similar ways of responding to parallel situations for reasons that can be observed and defined. This may afford a clue to his problem, and he searches for additional clues. He frames a hypothesis that the group under investigation originally acted from similar motives to the group about which knowledge is more complete. If his further search for clues is rewarded by additional evidence of the same type, his hypothesis is substantiated; if contradictory evidence is adduced, he must begin again. In any case his reliance on the psychological method of inquiry is clear.

1. One of the questions with which every anthropologist is, of course, vitally concerned is how primitive peoples think. On this matter opinions have ranged themselves into two camps, those who hold that primitive peoples think in very much the same way as more highly cultured peoples, so far as their circumstances and experience permit; the other view is that their minds work quite differently from that of more civilized peoples. The latter view has been championed by the school of French thinkers headed by Durkheim, and is especially propounded by Professor Lévy-Brühl. According to him primitive mentality is pre-logical. It is dominated positively by the law of participation, and negatively it is not subject to the law of contradiction. For that reason Lévy-Brühl deprecates the attempt to study primitive mentality by attempting to put oneself in the place of the savage. If we do that, he thinks we shall be sure to make the mistake of carrying our own methods of analysis and reflection into the primitive man's situation, whereas we ought rather to try to analyse the processes by which his mind works. The trouble with the school of Durkheim is that it fails to recognize the principle of evolution as applicable to social ideas, and theorises on the hypothesis that social ideas which now operate have been operative throughout all stages of human history. When Lévy-Brühl talks about primitive man not being subject to the law of contradiction, he really refers to such situations as would appear contradictory to civilized man. The important point is that primitive man experiences his sense of contradiction in quite different situations. In his own way he is as subject to the laws of logic as his sophisticated brother.

British anthropologists, on the other hand, have held to the idea of the continuity of mental and social processes. Our social ideas and their overt expressions are the products of long stages of development. The transition from primitive to civilized mentality is not sudden, but takes place through long and sometimes tedious processes. The study of these social processes through social institutions such as language, mythology, symbols, and ceremonials gives us the data whereby we must interpret the mental life. The mental life and the social setting need to be studied side by side. Each will help materially in the interpretation of the other. The gap that separates primitive man from civilized man, judging from all the evidence that is available, is much more social than individual. There is no great disparity between the mind of the savage and the mind of the civilized. Differences are much more largely due to social traditions, customs and organizations. This view of the British school is one which modern psychological investigators tend to corroborate. In so far as psychological tests of intelligence have been applied, the surprising result has been the smallness of the differences, differences that in most cases could quite readily be attributed to the long play of environmental factors.

It has frequently been suggested that one difference between primitive mentality and civilized mentality is in the acuteness of sense-perception. A sportsman takes a native shikari with him in his search for game, and he finds that the shikari is possessed of unusual sensitivity in regard to the signs of game. He is alert for sounds, odours and visual evidences, and ready to interpret their significance. He will tell you what animals have been in the neighbourhood and approximately when, by the tracks of their hoofs, their droppings, and the trees against which they have rubbed. He seems to see and hear and understand the simple signs of nature much more than the sportsman whom he is serving. But have we any psychological justification for concluding that primitive man is gifted with greater acuity of sense-perception? As a matter of fact, not much experimental work has been done on the basis of which scientific conclusions are possible. Moreover, sense-perception is not a distinctively human ability, and some of the senses are more developed in some of the animals than in man. Bruner in his book, *Hearing of Primitive Peoples*, has demonstrated that the auditory powers of the savage are, if anything, duller than those of the civilized. His general conclusion is that "Other things being equal, those individuals or races possessing the greatest complexity and variety of reactions to elements in their respective environments likewise will be gifted with keener and more acute sensory mechanisms." (Quoted by Thomas: Social Origins, p. 158.) The more acceptable view of the matter seems to be that differences between primitives and civilized peoples, whichever has the advantage, are explicable on the basis of habits of interested attention, growing out of their different modes of living. A primitive group that lives largely by the hunt naturally develops to a more accurate degree the ability to interpret such signs as are important in the tracking of animals, but their superior skill in such matters does not mean any superior visual acuity.

Another suggestion that has sometimes been advanced is that the will of primitive man is much less restrained than the will of civilized man. This view no doubt arises from the observation that he is not subject to the specific restraints which we ourselves experience. It is really the psychological error of imagining him to be responding to our situation. As a matter of fact, anthropologists invariably find that, though the primitive group is not restrained in certain social matters familiar to us, he is quite as much hedged in by the social traditions and taboos that characterize his own culture. A good deal of the argument about the freedom of the will is purely academic. Psychological observation makes it plain that man is neither a pre-determined mechanism nor absolutely free. Among the influences that place limits upon his freedom, the folkway is one of the most important. All of us in India are familiar with the tyranny of the *mammul*, which dominates the life of the individual in matters social, economic, and religious. In innumerable matters of every-day life, the individual is scarcely conscious of any alternatives for conduct. What has been done, is done, and must be done. If we contrast different groups in this matter, I submit that we shall find the precise opposite to the popular opinion. It is the educated man, who has learned to reflect on life, who enjoys the greater measure of freedom, because he is conscious of a wider range of choices, a greater variety of alternatives. The more primitive a people is, the narrower is its outlook on life, the more circumscribed its consciousness of selection, and the less its ability to choose. If one reads any of Mr. Sarat Chandra Roy's studies of the tribes of Chota Nagpur, for example, he cannot but be impressed by the limitations put upon the individual's behaviour by the group at every stage of his life. He may not be subjected to some of the restraints which members of a more highly cultural group place upon themselves, but the minutiæ of his restraints are far more intricate. In every detail of behaviour connected with birth, initiation, marriage, death, the forces of nature, and occupational interests, there is already an established custom which determines what the individual must do. He cannot start on a simple journey without observing the ominous signs. He does not dream without conduct being influenced thereby. If the social organization be totemic in character, the individual is subject to restraints in matters of food and drink, marriage and residence, and in regard to the conduct of the various group ceremonials. Nothing could be more fatuous than to suppose that primitive peoples have the advantage over civilized in respect to freedom. On the contrary, they are the victims of innumerable restraints which society imposes upon them at every turn.

2. There is a wide group of problems that arise in connection with the ethnological analysis of culture, towards which

psychology may contribute both in matters of method and the understanding of the processes involved. Much misunderstanding has arisen from the habit of supposing that we may carry over the differentiations of our own cultures to the interpretation of primitive culture. It should not be forgotten that the distinctions we make between magic, science, morality, religion and art are the outcome of long and slowly developed processes of reflection. Moreover, when we undertake a critical analysis we discover that our distinctions are even yet difficult to define. For primitive mentality the environing universe is an undifferentiated continuum, characterised by appalling realism. Life for people of the primitive cultures is for the most part a curious medley of customs, beliefs and practices, with no effort at analyzing or classifying them into different groups or concepts. The lower the stratum of culture, the more simple are human wants and satisfactions, and the more evident that life is treated as an unanalyzed totality. The increase in population, the increase of social contacts, and the rise of divisions of labour induced experiences of crisis, necessitating the growth of reflective processes to deal with the changing conditions of life. Among the products of this mental development, we have the more rapid development of symbols and language, and the growth of the consciousness of personal identity. Gradually there emerged more of the analytical turn of mind. Interests and objects became more and more differentiated.

One of the distinctions which man slowly learned to make was between the organic and the inorganic. In many types of primitive culture that have been observed, there is the sense of a mysterious occult power pervading the whole environment. The Melanesians called it *mana*, but this concept has many parallels. Here in India the word '*sakti*' in its broader connotation stands for the same transcendental power with its wide diversity of manifestations. Primitive people think of this power as resident in things as well as trees and plants, in the lower animals as well as men, in the powers of nature as well as catastrophic events. To be sure, some objects and some phenomena exhibited more *mana* than others. Some rites and some persons possessed more '*sakti*' than others. But there was no prognosticating where and when it might be manifested. It must have been a great discovery for the human mind when it began to realise the difference between living objects and non-living objects. With this discovery, the idea of *mana* naturally came to be associated predominantly with things living. Animistic ideas are doubtless one phase of the development of the belief in *mana*. Naturally, the notion of soul-substance is more relevant to living things than dead matter. The concept of soul-substance is one of the most important elements in primitive psychology. It was broadly the notion of a mental or spiritual portion of a man, animal or plant in distinction from the purely physical. For a long period in the early history of religion even stones and other inanimate objects were believed to have latent *mana*, or soul stuff.

How did primitive man arrive at his idea of a soul? Philological study throws some light upon this question of origins. There are many languages in which we find the same word for 'breath' and 'soul,' a fact that points to the observation that soul was the vital part of a man. There are a number of primitive tribes to-day in the South Sea Islands and in Africa who use the same word for both concepts. The Hebrew, Greek, and Latin words point to the same usage. The word ψυχή found in our word 'psychology' originally meant the vital breath. I need scarcely remind you of the same double meaning that at one stage attached to the Sanskrit words *prana* and *atman*. It seems clear that a number of customs that still survive owe their origin to an original belief in the identity of the breath and the soul. The idea that yawning involves danger is significant in the light of this conception. The restraint on crossing over a sleeping person points to the primitive notion that the soul temporarily leaves the body during sleep; and to the consequent danger of crossing the body when the soul might be on the point of returning, and thus frightening it away. There is also the practice among some castes of trying to catch the last breath of a dying man, by placing the ear to his mouth. The essential character of breath to life was doubtless the origin of this belief which was re-enforced by the daily experiences of life and death. Another observation is that in a great many languages the word for 'shadow' is used as the word for soul. Some have one word only for shadow, reflection, dream and soul. The shadow or reflection is regarded in such cases as an appurtenance essential to life. At death the soul leaves the body; the shadow is no longer cast. This life principle is neither essentially physical nor essentially psychical, because the difference between physical and psychical facts was only beginning to emerge. Many Indonesians believe that if the shadow falls on food, it should not be eaten. These observations of the social consciousness of living primitive peoples are suggestive of a basis for the interpretation of certain Indian beliefs and practices. They suggest for example that the beliefs in the pollutive character of the shadow of a non-caste man, or in the unpropitious character of the shadow of a widow may point to a time when the soul was associated with the shadow. The idea that you can distinguish a ghost from a human being by the lack of a shadow, the notion subsequently associated, *e.g.*, with the *sukshma* and *karana* bodies, is also suggestive. In Indonesia to-day there is a belief that the soul-substance leaves the body at death whereupon another spiritual entity, the ghost, takes its place. There are many Indian customs such as forbidding children to play with their shadows, not allowing a very young child (under one year) to look into a mirror, avoiding the reflection of oneself in water, the practice of a father first seeing the reflection of his child in gingelly oil when it is born under an unlucky star, and the belief that if a man does not see his shadow it forebodes death within six months, which suggest that in former times the connection between the shadow and the soul was very real.

Another curious belief which primitive psychology discloses is the widespread notion that a man possesses more than one soul. In New Guinea there is a belief in two souls, a long and a short; the long one is the shadow, and the short one, leaving the body at death, goes to the underworld. The ancient Egyptians believed in two souls, one that flew to the sun in the form of a bird, and the *ka* or double that inhabited the statue representing the dead man. There are evidences of certain differences of belief among Indians as regards this same question. In the Brāhmaṇas and Upanishads the number of vital breaths is described differently. The word *prana* seems to have been used not only for the vital breaths, but sometimes for the sense of smell, or for all the senses, and at other times for the Absolute. In the Taittereya Upanishad and other Upanishads *prana* is used as representing a conception of the soul, a little higher than the purely physical, but lower than the mental. Popular belief to-day still adheres to the existence of five *pranas*, which are separated when the person dies, one remaining where the man died, one where the funeral rites took place, one at the cremation ground, one going to the kingdom of Yama, and one being re-incarnated. I think I am right in the opinion that this belief is disappearing gradually, and that most people believe in but one soul, just as modern psychology believes in an integral unity of personality.

3. Reference has been made to the widespread belief in a mysterious power, *mana* or *sakti*, which pervades the environing universe. It is obvious that people who share such a belief should desire to be on good terms with a power with such possibilities for weal or woe, and therefore should seek to control it or conciliate it, to evade it or to annul it, in accordance with their ideas of its character. When people have only vague ideas of that power, and when their ideas are not disturbed by any sense of contradiction, as is so often the case, their attitudes toward that power may be quite confused. As a matter of fact many primitives see no incongruity between the use of persuasion and coercion at one and the same time. It is common to find people offering bloody sacrifices for propitiation, and practising mimetic magic for control. For example, in the effort to secure rain, two kinds of rain-making ceremonies are practised, one a conciliatory offering to the god of rain, and one mimetic magic to compel

the rain to fall. Here we see the element of truth that there is in Lévy-Brühl's contention that primitive mentality is less subject to the law of contradiction than civilized mentality. The two types of ceremony supplement rather than contradict each other.

We have grown accustomed to think that these two types of ceremonies are representative of incompatible attitudes. The conciliatory attitude we call religion; the coercive attitude, magic. Our logic requires us to hold them as disparate and contradictory. Yet even civilized man is not always logically consistent in his thinking, and frequently entertains ideas that are out of harmony with one another. People who are less sophisticated, and have not been trained to think logically, have still less of the sense of contradiction in the presence of discordant attitudes. May we account for that fact by supposing that religion and magic frequently have a common motive, directed to a common object? The center of interest is the felt need to be on good terms with the mysterious power so capable of help or harm. The differentiation, which is an achievement of later reflection, is to be found in the methods employed. Religion employs the social technique of entreaty or prayer; magic makes use of mechanical means, seeking to set up the necessary conditions which will make the desired result inevitable.

Psychologically speaking, then, the distinction between religion and magic is to be found in the realm of the attitudes. When a person is religious he adopts a socialising attitude towards his environment. He conceives of it as amenable to persuasion and entreaty, on the analogy of another person. When he is magical, he assumes a mechanical attitude, believing that if he fulfils the required conditions, the result he seeks will automatically follow. The environment is treated as if it were a mechanism, a knowledge of the intricacies of whose parts and functions is needed to secure control. But this differentiation, I repeat, is the outcome of processes of reflection to which primitive peoples have not yet attained. Consequently they find no sense of incongruity in behaviour that involves a mixture of the two attitudes. I suggest to you that the attitude that finds expression in the old legend, "The universe is subject to the gods; the gods are subject to the mantras; and the mantras are in the hands of the Brahmans. Hence, the Brahmans are the real gods," is a survival of the primitive mentality which made no effort to distinguish between the methods of religion and magic. If we bear in mind the fact that this distinction is a product of our sophistication, and avoid the practice of trying to apply it to the rites of many primitive tribes and castes, we shall better understand their behaviour.

4. There is another problem towards the solution for

which psychology and anthropology may very well co-operate, viz., the problem of kinship. We have a splendid example of such co-operation in Dr. Malinowski's studies in the life of the Trobriand Islanders, such as his " Psychology of Kinship " and "The Sex Life of Savages." His studies have shown clearly that it is impossible to understand the family life or kinship relations of a group, unless one discovers the functioning ideas back of their customs. The Trobriand Islanders furnish a curious example of a group where the family is a recognised institution, and yet where the fact of paternity is not understood. Physical fatherhood among these people is not known, and yet fatherhood in a social sense is considered necessary. The spirits give to a woman her child, but fecundity in virgins is to be discredited. The process of introducing new life into the community is a business in which the spirits co-operate with a female organism. The man of the house is socially a father inasmuch as he is the protector of his wife, to whom he is rightly married, and of her children. But sexual life begins very early with these people, years before marriage is consummated. In such a society it is easy to see how greater importance should be attached to the brother than the husband or father of a woman. The physiological kinship between a sister and brother is apparent; but to this day they scorn the suggestion of physiological kinship between a mother's husband and her child. The result is that much importance attaches to the maternal uncle in all ceremonial matters concerning the family. He possesses rights of guardianship, and his consent has to be obtained in arranging marriages. A boy takes his village from the place his maternal uncle resides, whether it be near or far. The maternal uncle is the authority to whom matters of dispute are referred for settlement. When a girl is about to be confined she goes to her maternal uncle's house for the purpose. So in all sorts of ways his authority and importance are recognised.

It is commonly supposed that in early totemistic societies the fact of physical fatherhood was unknown. In fact, one of the explanations of the origin of totemism is that a woman, when she first recognised the signs of life within her, identified its origin as due to some animal, tree or plant seen at the time. Now totemistic societies are, as a rule, exogamous, and many of them are matrilineal. A boy takes his totem from his mother rather than his father, who again may be recognised socially but not physiologically as the boy's father. We are very much in need of some careful investigations into the extent to which totemism was characteristic of early Indian society. There are a few totemistic tribes still extent in various parts of India, and the names of many gotras are suggestive of a totemic origin, as does also gotra exogamy. This is confirmed by many cases of restrictions about injuring or eating the animal or tree, the name of which is taken by the members of a gotra. In Malabar we have also an example of matrilineal society. Whether this evidence confirms the opinion of some scholars that primitive society was everywhere totemistic or not, need not be argued. It will suffice to say that there must have been a good deal of totemism in primitive times in India.

I need not remind you of the importance of the maternal uncle in many social groups in India. His authority is recognised in connection with ceremonials and social arrangements of many kinds. Is there any explanation of the origin of his importance? It is impossible to suggest any hypothesis that can be established with certainty, or perhaps to suggest one that will be acceptable to many. If we employ the comparative method of group psychology, we cannot but wonder whether it is associated with a totemistic organisation that was widespread in primitive times, and whether it suggests a time when the father's place in the family was recognised socially but not physiologically. There are a few tribes in India (*e.g.*, the Erukulas of Madras and Karens of Burma) who practise the 'couvade' ceremony which is invariably associated with the discovery of the hitherto unknown fact of physical fatherhood. When a Erukula mother is taken ill she immediately informs her husband who dons some of her clothes, goes to bed and takes medicine to induce an easy confinement. Interestingly enough, the place of the maternal uncle in this group is very important. His consent must be obtained for a marriage, and a small coin that seals the bargain is given to him; in fact if he chooses he may reject the agreement made by the parents, and claim a girl himself. I quite admit that evidence is very scattered, but I suggest to you the possible hypothesis that the present-day importance of the maternal uncle dates from a time when the facts of physiological paternity were not understood or were only beginning to be understood. Psychologically speaking, this seems to be at least a possible motive to account for the unusual importance that has come to attach to him, and which seems with present day knowledge more like a survival than a natural or logical function.

It is important to remember that no people ever invented a superstition as such. A superstition is a survival in the sphere of beliefs or practices that were created to meet a felt need. When the belief or practice persists after the experience of need has either disappeared or been otherwise satisfied, we are dealing with a left-over, a superstition. Undoubtedly in a land like India where the folkways are undergoing so much change, there are a good many beliefs and customs that can best be interpreted as survivals. The task of discovering what needs were originally served by them, in other words what motives prompted them, is essentially a psychological task. I have given four examples of this type of problem, and tried to indicate the manner in which a psychological approach may be of service in reaching at least a working hypothesis. My concern is not so much with any hypothesis I have suggested, but with the importance of the psychological method in the solution of anthropological riddles. In particular my plea is that anthropological workers in India should take full advantage of psychological technique in their efforts to solve the many fascinating problems presented to them here.

Section of Psychology.

Abstracts.

1. Two cases of Juvenile Delinquency successfully dealt with by Psychological Methods.

CAPT. H. STEDMAN, Simla.

Case I. English boy, aged 17 years.

Expelled from school for sodomy.

Intelligence Quotient 120.

Adventurous disposition, with considerable mechanical ability.

Oedipus complex, with mental conflict due to premature initiation to masturbation. Entered Engineering College in branch of Engineering which will give scope for love of adventure.

Case II. Anglo-Indian lad, aged 20 years.

Contemplating suicide owing to worry concerning his own supposed mental deficiency.

Intelligence Quotient 100.

Worry relieved by Intelligence Tests, but cause of backwardness found to be due to fixation of sexual desire upon sister.

Confession of two attacks upon the girl.

Reconstruction followed by attainment of confidence and happiness.

2. Suggestion in Practice.

W. NUNAN, Bombay.

Hemicrania, one of the most difficult problems in general practice.

"Spasmodic" and "congestive" schools of thought. Team work by specialists essential, but not always successful.

Polypharmacy in Migraine.

Exclusion of air in Migraine.

The duty of the physician-psycho-therapist to fade out of the picture.

Opposition of the profession to psychic treatment.

Alleged temporary effects of Suggestion. *FIAT JUSTITIA RUAT COELUM.*

Differential Diagnosis.

Post-alcoholic insomnia ? or post-insomniac alcoholism ?

"Melancholia", "oral sepsis" or both ?

Hysteria ? Hystero-Epilepsy ?

Epilepsy ?

The abuse of the Bromides.

The inferiority complex.

The limitations of Suggestion.

The Ubiquitous mental co-efficient.

3. Psycho-Therapy.

W. NUNAN, Bombay.

Definition of Psycho-Therapy.

Psycho-Therapy capable of general application.

The mental co-efficient in Disease.

The mental factor in Malaria;

The *rationale* of Psycho-Analysis.
Free association.
Word association.
Pit-falls of Dream-Analysis.
Time-Reaction in Word-Association.
Functional and Organic Disease.
The Utopian conception of the Insurance world—a First class Life.

4. The Schizophrenic Reaction.

Frank Noronha, Bangalore.

The concept of Schizophrenia and its various manifestations. Its social significance. Its appearance in the apparently normal. Psychoanalytic explanation of the reaction. The development of the personality and the concept of the Ego-ideal. Symptom formation depends upon the failure of the Ego-ideal. Descriptions of some symptoms and their explanation. Application of these principles to criminal conduct.

The widespread tendency to Schizophrenic reaction. Its prevalence in a mild form among individuals who show personality deviations.

5. The Aural Significance in Mental Disorders.

P. P. Narayanen, Ranchi.

The ear as an organ of conception in mythology. A totem for the primitive people. Boring of the ear among the Bechuanas as a ceremony of circumcision. Diseases and deformities of the ear found in physical ailments. Ear in criminality. Anomalies of the ear associated with mental disorders and deficiency. Incidence of abnormal ears among the inmates of the Ranchi European Mental Hospital.

A deformed ear in the child should be taken as a note of warning by the parents.

6. Modes of Action of Physical Factors in the Aetiology of Mental Diseases.

Lt.-Col. A. N. Overbeck-Wright, Agra.

I. Trauma.

(*a*) Praenatal:—Results of injury to mother when pregnant.

(*b*) Natal.

(*c*) Postnatal:—Results of direct injury to brain including concussion of base from falls on heels or buttocks.

1. Shock:—I. Exhaustion of cell oxygen
II. „ „ electric charge of cells.

2. Result of embolism, occlusion of artery as in arteriosclerosis rupture of artery.

3. Local inflammations and diseases of brain and membranes.

4. Sun, heat, and moonstroke.

5. Results of high temperatures on nerve cells.

II. Long continued chronic diseases.

III. Toxaemias.

1. Metabolic.
2. Bacterial.
3. Drug toxaemias.

IV. Bloodpressure.

V. Reflex Psychic Action through Autonomic Sympathetic System of Langley.

VI. More psychic than physical.

(*a*) Fear of contracting infection without any cause existing for this fear.

(*b*) Fear of contracting infection after exposure.
(*c*) Fear of passing on infection after contracting it.
VII. Critical Periods of Life.
VIII. Conditions peculiar to women.
IX. Epilepsy.
X. Prolonged physical and mental strain including sexual excesses.

7. Primary action necessary for the Treatment of Mental Deficiency in India.

Lt.-Col. A. N. Overbeck-Wright, Agra.

Evolution of modern methods in England, a century from Bedlam to modern institutions.

Steps attained in this progress:—

(*a*) Education of populace to a true knowledge of such conditions.
(*b*) Compulsory primary and secondary education.
(*c*) The developement of a satisfactory method for diagnosing Mental Deficiency.
(*d*) The formulation of standards of average mentality at different ages for different races, classes, and castes.
(*e*) The training of a competent staff to weed out cases of Mental Deficiency and conduct homes for M.Ds.
(*f*) The provision of homes for the training and reception of such cases.

Conditions as they exist at present in India and action necessary to attain these essentials.

8. Effectivity of verbal and pictorial presentation of meaning.

N. S. N. Sastry, Mysore.

It is doubtful how far pupils below a certain age are profited by the 'Verbal Method' of teaching alone. It seems that the use of the 'Illustration Method' is a necessary supplementation to the verbal method. How far the pupils of the several age and class groups are affected by verbal and pictorial presentation of meaning needs investigation.

The P.G.R. was made use of in denoting the emotional intensity for pupils when either the picture or its title was shown to them. Sixteen pictures and 16 titles were used. The higher emotional deflection in the Psycho-galvanometer, for either presentation was taken as the 'preference'.

Judged on this basis the primary class of the average age of ten showed the highest preference to pictures and lowest to the titles, while the VI Form class (average age 17) showed distinct preferences to titles and not to pictures. There is gradual transition in the preferences from the children's group to the adult group, the preference from pictures to titles, changing over at about the age of thirteen.

As far as the education of the feeling of the child below the age of thirteen is concerned, it might profitably be supplemented by the use of the "Illustration Method".

9. Effectivity of Presentation of Verbal Stimuli in the Mother-Tongue and Foreign-Tongue.

N. S. N. Sastry, Mysore.

The paper records the results of experiments carried out to find out whether vernacular is better than the foreign tongue, at least in arousing and regulating certain desirable emotions and impulses.

Two poems from well-known English Poets and the best available Kannada translations of them were chosen and the patients were presented with these stimuli. The Psycho-galvanometer, as per the modification of Smith, was used to note the resulting emotion. The total deflection of the patch of light was noted down in either case and then converted to percentage fall of resistance.

Judged purely by the aggregate emotional intensity, the group shows marked excitability in the vernacular and not in English. When judged on the basis of co-efficient of superiority in Kannada, *i.e.*,

$$\frac{\text{Total \% age fall in Kannada} - \text{Total \% age fall in English}}{\text{Total \% age fall in English}} \times \frac{100}{1}$$

this preference for vernacular is brought out more clearly, the superiority of vernacular being as much as about 35%.

10. Cryptic jealousy.

J. K. SARKAR, Muzaffarpur.

Introduction :—Jealousy as a defence mechanism involves more of self love than of love. Freedom from jealousy in love is not an indication of self-control but of over-estimation of one's own merits covering up one's own inadequacies.

This paper shows how in jealousy the life of a person is more enacted in phantasies than in reality—how the fear of self is greater than the fear of others.

That cryptic or unconscious jealousy is often fused with or related to homo-sexuality is illustrated by concrete cases.

Morbid jealousy has different forms and involves various mechanisms, *viz.*, subjective and objective identification, substitution, introjection, and projection, etc. All are instanced by cases thoroughly analysed.

Conclusion :—Jealousy is hidden from consciousness by the guarding self.

11. Cyclopean Point in Touch.

K. C. MUKHERJI, Dacca.

A close resemblance is marked in this paper between the tactual and the visual senses in the act of localisation in fusion.

12. A Review of Psychological Standpoints.

K. C. MUKHERJI, Dacca.

Different Psychological standpoints have been critically reviewed in this article with a purpose of studying them in a comprehensive way.

13. A Psychological investigation of ability with symbols.

A. A. KRISHNASWAMY IYENGAR, Mysore.

This paper continues the investigation reported at the Psychology section of the Indian Science Congress, last year.

The results of a test on the interpretation and use of symbols with *no* mathematical content are here analysed and correlated with those of a similar test involving *only* mathematical symbols. The tentative conclusion reached is that what matters initially is an inherent taste or aptitude for symbolic work and not the nature of the symbolic content. If this view be correct, workers in diverse fields of symbolism such as the shorthand writer, the Morse-signaller, the hand-writing experts, and the pure mathematician should have at bottom the same fundamental symbolic ability.

14. Social Instincts.

Mohamed Aslam, Lahore.

A criticism of the common practice of classing certain instincts as specifically social, and a new analysis of facts usually covered by the term, Social Instincts.

15. An experimental approach to the Problem of Truth and Error.

M. V. Gopalaswami, Mysore.

Professor C. Spearman was the first to point out that the right approach to the problem of Truth is to study the causation of errors in thought and perception from the phenomenal point of view, the metaphysical aspect being left over for later occasion when sufficient empirical data and formulations have accumulated. He has shown from the study of a number of cases of illusions that all errors are ultimately traceable to the process of associate reproduction, and that the noegenetic process can in no manner whatsoever generate errors. If they work at all they must give rise to true judgments, which carry with them self-evidence and belief. The present paper is an attempt to apply Spearman's principles to the following classes of errors :—

1. Errors in learning; 2. Errors in Motor adjustments; 3. Visual illusions of extent, direction, etc.; 4. Illusions of time perception; 5. Illusions of movement; 6. Hallucinations; 7. False beliefs under hypnosis and suggestion; 8. Errors in Concept formation; 9. Spelling errors; 10. Errors in Speech; 11. Errors in æsthetic Judgments; 12. Errors in Social, Political, Educational, and Scientific thinking; 13. Errors in primitive beliefs; 14. Errors in Religious beliefs and practices.

General conclusion—Consciousness being a proficient organ tends to construct the future. There is always in such a process a jump from the known to the unknown, and hence the possibility of error. Most of the types of errors appear to rise from the tendency of the mind to construct the future with insufficient data or irrelevant data, the irrelevant data being supplied by association and later description, and often also by wish or impulse.

16. The Relation between Mental Efficiency and General Health.

B. Venkatesa Sastry, Tumkur.

An attempt has been made to correlate the mental efficiency of some Secondary School children with their physical state. Weight, height, condition of nutrition and presence of disease, if any, in each of the three High School grades are taken to indicate their physical condition; the relative standing of each pupil in his class as determined by his performance throughout the year in his class and in the annual examination is recorded to denote his mental efficiency.

17. A Review of Spearman's Principles and the Laws of Gestalt.

G. Hanumantha Rao, Mysore.

I. Outline of Spearman's Principles.
II. Outline of the Gestalt psychology of cognition.
III. 1. General comparison.

(*a*) While Spearman leaves the psycho-physical connections underlying the qualitative principles "utterly mysterious," the configurationists attempt to show that the physical, physiological, and phenomenal patterns have indentical formal properties.

(*b*) The latter have gone further and tried to show that facts of quality could be brought under the laws governing spatio-temporal configurations.

2. Comparision of Principles.

(*a*) Spearman seems to assume that lived experience is experience without awareness. This is difficult to understand. Even the most primitive experience reveals an awareness of a contour against a background.

(*b*) Spearman starts with aggregates of character which are the results of laboratory analysis rather than with concrete objective patterns.

(*c*) Relation-finding on the configurational assumption is easier. At least, the attributive relation is more easily conceived with reference to a configuration.

(*d*) Transitions from the first principle to the second and third more easily conceived on the configurational laws.

IV. What the Gestalttheorie should do, but has not done.

18. Has Lived Experience always a Tendency to evoke an Awareness of its Experiencer ?

G. HANUMANTHA RAO, Mysore.

In this paper, an attempt is made to examine Spearman's Principle of Apprehension in the light of evidence—experimental and observational—obtained from the fields of adult and child psychology.

Spearman holds that all lived experience tends not only to evoke immediately a knowing of its character but also of its experiencer. (1) Results of experiments with adults show that while every subject reports that there is a tendency to become aware of the character of a lived experience, most subjects do not experience any tendency to become aware of the experiencer. (2) Facts of genetic psychology also run counter to Spearman's contention. The tendency to become aware of the experiencer pre-supposes self-consciousness. It is shown by Prayer and other child-psychologists that consciousness of the self or I-feeling, is not present to the new born child and that it develops in him, in the course of about twenty months. The child's knowledge of himself is seen to develop in and through his knowledge of the external world. Before he is aware of himself, he is aware of many things in the external world and has established relations between them. It is in and through this finding of relations between objects of the external world that the child develops an integrated nervous system. It is only when an integrated nervous system is developed that the I-feeling is developed. This I-feeling which arises as a result of the Second Principle of Relation-finding cannot be fundamental to the First Principle of Apprehension.

19. Concept formation and general Intelligence.

B. KUPPASWAMY, Mysore.

Introductory.—General intelligence in a sense may be defined as the ability to abstract relations from a multiplicity of divergent items. Nearly twenty years back, Dr. Abeling brought to prominence the method of concept formation from the experimental point of view. The present paper reports an attempt to study the relationship between general intelligence and concept formation by the Abeling method. Since in this method pictures are used, it will provide a very good non-lingual test of intelligence, and one which is capable of universal application.

Procedure.—Five subjects sets of pictures representing churches, monuments, animals, children and natural scenery were used. Behind each picture representing the different series the following nonsense syllables were written; Funep, Gazod, Batfud, Benep, and Zavos. Twenty-three psychology student of the B.A. Class served as patients in the experiment. A measure of their general intelligence was obtained by administering the following tests. The Analogies, Absurdities, Mixed Sentences, and the Number Completion Test. Success in the Abeling test of concept formation was estimated in terms of ability to give the correct meanings for the different nonsense syllables.

Results.—The correlation between the Aveling test and general intelligence by the Foot-Rule method of Spearman is found to be 0·59. On conversion into *r*. it is as high as 0·82 with a P.E. of 0·05. This high correlation, if it could be sustained with a larger number of cases, would appear to support the theory that at least one important function in intelligence is the abstraction of relations. From the practical point of view this has an important application, *viz.*, that if a properly graded series of pictures could be used it would form a very good test of intelligence which would be independent of the language factor. Also to most people such a picture test would be very interesting and therefore engage their whole attention. Such a standardisation is in progress and will be reported on a subsequent occasion.

20. Pitch Discrimination and 'General Intelligence'.

B. Kuppaswamy, Mysore.

Introductory.—Nearly 25 years back Professor Spearman reported a correlation of 0.94 between Pitch Discrimination and 'General Intelligence'. Burt also reported a correlation of 0.50. But Seashore found that there was no correlation between the two abilities. The Pitch Discrimination Test has many advantages over other tests of 'Intelligence,' *e.g.* :—(1) it transcends language boundaries, and is capable of universal application, (2) practice effects are very limited, (3) it could be easily administered at all ages above 5 years without any arbitrary change of material as is involved in most other tests. In view of these and other advantages it would seem desirable to determine the degree of relationship between ability in the Pitch Discrimination and the 'General Intelligence' Tests.

Procedure.—45 students of Psychology of the final year B.A. Class served as patients in this investigation. To measure Pitch Discrimination two tests were employed :—(1) Seashore's Gramaphone Plate Test, and (2) Seashore's Tuning Fork Test (with 435 as standard, the variables ranging from 0.5 to 30 V.D.). Both the tests were conducted as group tests, after a little preliminary practice period. In scoring the responses two procedures were adopted, *viz.*, (*a*) the total number of correct judgments out of a possible 100, and (*b*) the least perceptible difference in pitch. The patients were required to report whether the second sound was higher, lower, or equal to the first sound. About 10 to 12 stimuli were given at each range of difference, beginning with the largest difference (30 V.D.) and working downward towards the least difference (0.5 V.D.).

As a measure of 'General Intelligence' the Absurdities, the Analogies, the Opposites, and the Number Completion Tests were employed. The scoring in each of these tests was on the basis of the P.E. of distribution as the *unit of measurement*, the *Median class interval* being treated as *zero* point on the scale.

Results.—The following are the correlation co-efficients obtained between Pitch Discrimination and 'General Intelligence'.

	GRAMAPHONE TEST.		TUNING FORK TEST.	
	Total No. Rt.	Dif. Threshold.	Total No. Rt.	Dif. Threshold.
General Intelligence..	−0·04	0·07	0·04	0·12

Conclusions.—Thus there appears to be little or no correlation between Pitch Discrimination and 'G' as estimated by all these four methods. This is in conformity with the findings of Seashore.

The high correlation obtained by Spearman, and the moderate correlation reported by Burt, it may be noted, were obtained with Spearman's Dischord; also the test was conducted individually.

21. Individual Differences in Aesthetic Appreciation.

S. PUTTANNIAH, Mysore.

Introductory.—Although it is difficult to define what beauty is, it is often possible to point out a beautiful object. But different people have different ideas as to what constitutes the beautiful. Sometimes they are conscious of these ideas, but more often their judgements of the beautiful are effected by a large number of unconscious elements. That this is so, is brought out by the present study of individual differences in æsthetic appreciation.

Procedure.—A series of eleven pictures of Indian women were used for the purpose of this experiment. The following two methods were followed in the study.

A. (*a*) 33 students of the B.T. Class judged by the method of paired compassion. The test was administered as a group list by projecting the pictures with the help of a magic lantern. The patients were required to indicate their preferences as each picture was presented in conjunction with each picture. The total number of preferences obtained by each picture from each patient was taken as the final score in estimating their relative position on the scale 'beauty'—'ugliness'.

B. The same pictures were given to an equal number of post-graduates and final year B.A. students as an individual list, the patients being instructed to grade the pictures according to the descending order of 'beauty-ugliness'. In this case the ranking given to each picture was taken to be the final score.

Numerical Results.— *Picture number.*

No. of preferences.	1	2	3	4	5	6	7	8	9	10	11
In A.	493	260	339	452	344	231	318	222	115	402	485
RA_1 Rank according to A	1·0	7·5	5·0	3·0	6·0	7·5	9·0	10·0	11·0	4·0	2·0
RA_2 Total No. of I and II places given in A.—Rank	18 1·5	2 8·0	7 5·0	9 4·0	4 6·0	1 10·0	2 8·0	2 8·0	0 11·0	12 3·0	8 1·5
RB Rank according to B	3·0	10·0	2·0	5·0	5·0	5·0	7·5	10·0	10·0	7·5	1·0

Applying Spearman's formula R
Correlation co-efficient between RA_1, RB 0·9775 whence r 0·999
PE $\pm 0{\cdot}0028$.
,, ,, RA_2, RB $= 0{\cdot}5$ $r = 0{\cdot}732$ PE $= \pm 0{\cdot}0945$.
,, ,, RA_1, $RA_2 = 0{\cdot}5$ $r = 0{\cdot}732$ PE $= \pm 0{\cdot}0945$.

In both A and B, the same 7 out of 11 pictures were given the 1st or 2nd place by some one or other and picture eight was always given a place beyond the 5th.

Introspective results.—From the introspective reports obtained from the patients in group B, it is found that they spontaneously adopted different view-points and standards of judgments in indicating their preferences. These view-points could be roughly divided into the following classes following C. W. Valentine in his 'Psychology of Beauty.'

1. *Objective view.*—Beautiful because, symmetrical eyes, large oval faces, wide eyes. Not beautiful, because, very lean small face, shortness.	Attention on the spatial attributes of the features as same.
2. *Physiological view.*—Beautiful because, energetic, cheering, exciting.	The effect of the picture on the patients.
3. *Associate view.*—Judging on, things, persons, and modes revived.	On things and persons revived.
4. *Character view.*—Beautiful because simple, innocent, modest, jovial, tender. Not beautiful because, haughty, cunning, voluptuous.	Character as read from the face and posture.

These view-points are taken in different degrees by every individual and seldom occur alone.

The vast amount of difference noticed in judgment noted in the table of results, may be accounted for, in the light of introspective evidence, as due to the adoption of different view-points which must necessarily result in different and fluctuating scales of value.

22. Psycho-Thermionic Reflex: Its Application to the Detection of Crime

M. V. Gopalaswami *and* S. Puttanniah, Mysore.

Introductory:—That, when a person is included in an electric circuit in addition to a galvanometer and excited by a stimulus, his body shows an apparent fall in resistance is an established fact. A criminal may be expected to be more affected than an innocent person by criminal statements, under otherwise identical conditions. If it is, therefore, possible to detect and measure this comparative excitability, it may be possible to distinguish a criminal from an innocent person. Such a possibility is shown by the present experiment. The electrical behaviour of the skin is here called 'Psycho-Thermionic Reflex' as its detection and measurement involves the use of a thermionic values just to distinguish it from the Psycho-galvanic Reflex which is measured without the use of such a value.

Procedure:—The patients, taken at random, were sent together to a room. One of them was instructed by a stranger to take without the knowledge of the other an article kept in a box. The two patients were instructed to return together to the experimenter without talking to each other. They were comfortably seated in chairs and included in the circuits GP, P, GP_2, B_2, respectively. Thus one of the patients was a 'thief' and the other innocent. The experimenter knew only the object stolen. His object was to find out the culprit.

The direction of deflection corresponding to each patient was determined by a preliminary trial. Then the following four methods were adopted in order.

I. *Repetition of statements* :—Here the stimuli were short statements easily intelligible to both the patients. They were about 15 in number; some ordinary and some significant. The patients were instructed to repeat simultaneously each statement as soon as it was made. During the short pause between giving instructions and presenting statements, the light showed a tendency to move to one side of the null point. This deflection and the defection for each statement were recorded.

II. *Repetition of statements with completion* :—The statements were short incompleted sentences, usually the last place being left blank. Some were indifferent and the other descriptive of the object 'stolen'. The patients were instructed to eventually fill up the blank in each statement and then to repeat them simultaneously. The deflection for each statement was recorded.

III. *Repetition of words* :—About 10 words some indifferent and some significant were presented one by one. The patients were instructed to repeat simultaneously each word as soon as it was given. The deflection for each word was recorded.

IV. *Free-association* :—Here the patients were instructed to give their free association for the words presented. About a dozen words were given. Deflection for each word was recorded.

The patients were instructed to place themselves in the position of a 'thief' and try by every means in their power to hide the fact from the experimenter.

The prediction as to who the culprit was, was made on two distinct grounds, *viz.*,

1. Relatively high frequency of deflections for 'significant' stimuli.
2. Relatively high total magnitude of deflection.

Final prediction was made on the basis of (1) and (2) taken together :—

Results :— %of success of prediction.

Method considered.	No. of cases.	According to (1).	According to (2).
I	45	74·8	83 7
II	36	75·0	85·7
III	33	78·0	86·6
IV	30	83·3	90·0

I to IV .. 45 cases .. Success 90%.

The descending of order of the methods from the diagnostic point of view is IV, III, II, I. Since the same ranking of the methods appears in (2) as well, it may be taken as reliable.

Introspective Results :—Introspective reports of the patients show that the 'thief' tried to deceive by trying to suppress emotion, giving false and true information and by maintaining a calm exterior, while the innocent tried to deceive by trying to play to the best of his ability the rôle of a 'thief'.

23. Intelligence of Infants.

V. Venkatachar, Mysore.

Problems :—Whether it is possible to note individual mental capacities and individual difference in mental development before one year.

Procedure :—Simple experiments with toys given to children in a natural free way, and also some of the items of physical development as holding head erect at 4 months, sitting with support at 6 months, sitting alone at 9 months, walking with help at 1 year, etc. Children were tested exactly on the date of, or in the period allowing 7 days before or after, the completion of the respective months.

Data :—So far 18 children in 4 months' level, 19 in 6 months' level, 16 in 9 months' level, and 17 in 1 year level have been tested. Reaction are given letter ratings as follows :—

1%	to	19%	Frequency	A
20%	„	49%	„	A
50%	„	64%	„	B
65%	„	84%	„	B
85%	„	100%	„	C

And *b* is taken as the average level of reaction for each level.

Results :—

At 4 months :—Average (B) are—Lifting chest prone, turning to sound of a bell, or rattle of spoon in a cup, eyes following a moving plate, blinking at pen, regarding a red cube, feeling uncomfortable at a paper on the face.

At 6 months :—Average (B) are–Sits with slight support, creeps or hitches, makes stepping movements, one hand manipulation, reaches spoon directly, blinks at pen, looks for a fallen object, clasps dangling ring, persistent reaching for dangling ring.

At 9 months :—Average (B) are—Sits alone, drops 1 cube for the 3rd cube, smiling or laughing at mirror image, hits cup with spoon, persistent reaching for dangling ring.

At 12 months :—Average (B) are—Says 3 words, inhibits on command, unwraps cube, Formboard circle inserted being shown, drawing object nearer by pulling the attached string.

24. A Mental Survey of the pupils in the Mysore City High School.

A. ANANTHARANGA CHAR, Mysore.

Dr. West found in Bengal that the ages as recorded in school registers were not reliable. Our experience in Mysore being similar, we found it almost a futile task to establish *Age Norms* for the different Intelligence Tests. The next best thing appeared to be to establish class notes confining oneself to school joining population. The present paper reports class forms and dispers on values for the following tests of intelligence.—Absurdities, Analogies Opposites, and Number completion which were found to be the most successful tests from amongst a large battery of tests. The survey includes the test results of about 1,800 pupils from the various high schools in the city.

25. Speaking Vocabulary in a Foreign Language.

M. P. WEST, Dacca.

The schoolmaster's problem is to predict future needs, and to supply varied needs in one class. The doctrine of "Formal Training" may be regarded as an attempt to cope with this problem. Formal Training never applied well to a foreign language: hence Grammar as a form of "generalized training". The Direct Method brought the schoolmaster face to face with his old problem. Word-frequency lists as an attempt at solution: their deficiencies. Basic English as an attempt on different lines. Indications of the probable solution of the problem.

26. Tests and Examinations.

G. B. BHATTACHARYA, Dacca.

Tests are more or less factors of teaching or preparation against Examinations which are generally qualifying for the determination of educational standing. These examinations are either selective or educational.

Promotion and School Final Examinations are really Performance Tests to determine the real educational standing of individual pupils. In order that these examinations may be of real value the questions should be so framed as to test the functions relating to the specific needs.

Teachers and Head-Masters have specific duties in designing and conducting these examinations and these examinations are of definite value to both. These are also of value to students.

The article finally discusses the practicability and utility of having internal examiners who should co-operate with the external examiners in order that these examinations may actually serve the purpose for which they are held.

27. The Psychology of Leadership.

G. C. CHATTERJI, Lahore.

Leadership a prominent feature of group Psychology. Neglected by most social Psychologists. Le Bon's Psychology of crowd mentality ignores the place, influence, and effect of Leadership. The so-called primitive and debased character of crowd mentality applicable only to leaderless crowds.

McDougall's view that organisation leads to the group rising to a higher level of intelligence and morality also fails to lay sufficient emphasis on the part played by Leaders in bringing about social organisation.

Freud gives a central place to Leadership in his group Psychology, but adopts too extreme a view, and also furnishes a false theory of the origin of Leadership.

McDougall correct in holding that the instincts of self-assertion, and submission must be invoked to explain the phenomenon of leadership. Ability to dominate, however, no longer adequate for position of leadership in modern groups. The growth of individuality on the part of each individual member of a group requires that the modern leader should *express* rather than impress his group.

General Discussions.

I. THE ORGANISATION OF AGRICULTURAL RESEARCH IN INDIA.

There was a joint session of the Sections of Agriculture and Botany at 11 A.M., on 3rd January, 1930. to discuss "The Organisation of Agricultural Research in India". A number of members of other sections attended. The President of the Section of Botany (Prof. P. Parija) took the Chair. Dewan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-chairman of the Imperial Council of Agricultural Research, opened the discussion.

SIR VIJAYARAGHAVACHARYA said:—The Imperial Council of Agricultural Research has been set up as a result of the recommendations of the Royal Commission on Agriculture in India. It consists of two bodies, one, an Advisory Board consisting of about thirty-six members and the other, a Governing Body of about nineteen members. The Advisory Board is a body of experts and contains representatives of all the Agricultural and Animal Husbandry and Veterinary Departments in India, of the Indian Universities, Research Institutes, and other bodies engaged in scientific research, and of persons of scientific eminence. The Governing Body may be described as a body of laymen and consists of all the Ministers of Agriculture in India, three representatives of the Central Legislature and representatives of European and Indian business community. For the purposes of administration the Research Council is in the position of a department of the Government of India Secretariat and gets an annual grant from Government which is subject to the same budget rules and rules of audit and financial control as ordinary government expenditure. For the purposes of research the Council has been registered as a society and is endowed with funds of its own for promotion of research, the dissemination of scientific, technical, and economic information and for the assistance of post-graduate training in agricultural sciences. At present, the greater part of its research funds is provided by the Government of India which, besides a capital grant of 25 lakhs, gives a recurring grant of 5 lakhs annually. A donation of 2 lakhs has been made by the Hyderabad State which has its own representatives on both the Advisory Board and the Governing Body. The expenditure on the research side is controlled by the Council itself, which has an entirely free hand untramelled by the ordinary Government rules. The constitution of the Council is believed to be similar to that of Research Councils set up in other Dominions of the Empire. Schemes of research are actually sanctioned by a body mainly consisting of administrators, but they act on the advice of the experts and men of science. In financing schemes of research the Council occupies the same position towards the Provincial Governments as it does towards the Central Government, and the same position towards non-governmental bodies as it does towards governmental organisations. It is as free to give its grants to a scheme of research put forward by a University or by a private individual as to a scheme promoted either by the Imperial or by a Provincial Government. There is a great opportunity here for Universities to play a large part in the advancement of agricultural research in India and the speaker hoped that advantage will be taken by the Universities of this provision He mentioned that already the Dacca University had had a grant and a Professor of the Agra College had also had another. The Council was keen on securing the co-operation of Universities in the function of research and he thought that the Science Congress would help in procuring such co-operation.

MR. B. C. BURT, C.I.E., Export Adviser to the Imperial Council of

Agricultural Research. said:—As the result of developments on both sides the position is now more favourable for co-operation between the universities and agricultural research institutes than in the past, since most agricultural colleges are affiliated to universities and many universities have raised their standard of teaching in pure science and made definite provision for scientific research. There is ample room for co-operation between the universities and those engaged on the improvement of agricultural practice, and the Imperial Council of Agricultural Research, on which the universities are directly represented, affords a new opening for such co-operation.

DR. H. CHAUDHURI, Reader in Botany, Lahore, said:—Mycology plays a very important part in the agricultural organisation of a country. The country suffers enormous losses caused by plant diseases many of which are preventable. It is quite true, as has been pointed out by Butler, that no increase in the number of men engaged in the struggle against plant disease in the mainly agricultural countries can be too rapid and that a constant supply of new men trained in their study is needed. For this at least one University in each Province should provide training in Mycology and, as in the Panjab University, introduce Mycology as a major subject for the Botany students in the Honours School or in the M.Sc. Secondly "Pest-gangs" as in the rubber plantations in Malaya may be maintained in India in each Province for combating the principal diseases of the important crop plants of the Province. The headquarters of the Province should also be the headquarters for the Pest-gangs. It should be run on the lines of German Potato Bureau. The headquarters should maintain a laboratory and be in touch with the different pest-gangs in the Province. An efficient and properly trained quarantine staff should be maintained at the ports and the provinces must also have power, in cases of epidemics, to prevent importation from an infected province and the right of penalising the cultivation of declared susceptible varieties. In this way we can successfully combat the plant pests.

MR. M. AFZAL HUSSAIN, Entomologist to the Government of the Panjab, Lyallpur, pointed out that the University of the Panjab had already taken steps to ensure co-ordination of agricultural research between the University and the Agricultural Department and that Professor Kashyap, Professor of Botany of the University of the Panjab, Dean of the Faculty of Science, would probably deal with this question more fully.

Regarding the Organization of Research Work in the Department of Agriculture he was of opinion that the greatest defect in the present system was the combination of research, teaching, administration, district work, and propaganda under the same officer. He maintained that a research worker should not be required to spend his time in administration—writing letters, signing travelling allowance bills, making payments, checking stores, and drafting reports—nor should he be required to undertake field operations. Further it was not for an investigator to approach the man behind the plough and explain to him the value of the results of research. This should be done by the 'middle man', the propagandist. The malady was so serious that he considered himself justified in suggesting to the Vice-Chairman of the Council for Agricultural Research to follow the example of the *hakim* who prescribed eye-lotion for a man suffering from pain in the stomach because of having eaten a burnt loaf. The cause of research could be helped greatly if schemes for the separation of administration, district work, propaganda, etc., from investigation could be undertaken and, if necessary, financed, so as to release the existing research staff of the Agricultural Departments from this extra burden and ensure their whole-hearted devotion to agricultural research. In support of his argument he quoted Dr. Tillyard, who lecturing before the Royal Society of Arts, said—"The progress that will be made in countries like Australia and New Zealand seems to me to depend, in a great measure, on the recognition of the principle which has been put to work so successfully in England, *i.e., the complete separation of research from administrative work.*" The same applied to India with a greater force.

Mr. M. Afzal Hussain also laid stress on the recruitment for the scientific sections of the Department of Agriculture. He stated that with a view to make agricultural colleges popular, the Departments of Agriculture were recruiting research workers for applied sciences from among the students of the Agricultural colleges, who were being trained as farmers. For research work in sciences applied to agriculture it was necessary to have workers who have received a thorough training in pure sciences. They might if necessary be given special training in Agriculture. Mr. Afzal Hussain stated that this was the opinion of eminent scientists and educationists in England.

If these two drawbacks were removed Mr. Afzal Husain was hopeful that Agricultural research would make very satisfactory progress

Dr. S. P. Agharkar, the Ghose Professor of Botany, Calcutta University, pointed out the danger that lay in divorcing teaching from research as proposed by Mr. Hussain. In his opinion teaching and research were, in a sense, mutually dependent upon one another and both benefited by the association. By his first-hand knowledge of one part of the subject the research worker is able to create interest in research among his pupils. Conversely, many problems for research are directly suggested by teaching.

Dr. Agharkar's further remarks were directed to point out the necessity of the Imperial Council suggesting the problems of fundamental importance on which it would be prepared to subsidise research by the staffs of the Universities. If this was done team work in the solution of particular problems could be encouraged and more definite results would be arrived at in a shorter time. In his opinion the present procedure of every worker selecting his own problems for which he requested assistance from the Imperial Council was likely to be wasteful owing to the lack of coordination between the work being carried out in different centres. So long as funds were available no great harm could be done even if the present practice is continued but a time would come when co-ordination of the sort proposed by him and concentration of effort on a few problems only would be forced upon the Council.

Dr. J. H. Mitter, Professor of Botany, Allahabad University, said:—"I feel that there can be a useful co-operation between the departments of Agriculture and Education in the matter of teaching. One department may be distinctly more favourably situated than the other for the teaching of a certain branch of Botany. For example, the Agricultural Department with a whole-time Mycologist at its command, has much better facilities for the teaching of Mycology and Plant Pathology than are ordinarily possessed by a University College. And similarly, pure Botany can in most cases be better dealt with in University Colleges. I suggest that the question of an exchange of short courses of lectures between University and Agricultural Colleges is worthy of serious consideration."

Professor J. N. Mukherjee, Professor of Chemistry, Calcutta University, pointed out that the Chemistry Section of the Indian Science Congress should have been formally associated with the joint discussion as chemical investigations form a substantial part of Agricultural Research. He expressed the hope that the Agricultural Research Council, while effecting the desired co-ordination of the efforts of various units working for the progress of Agriculture, will not fail to utilise in full the facilities in men and materials in non-agricultural and non-Government institutions. He referred in this connection to the desirability of providing facilities to suitable Chemists working in such institutions and of linking up their activities as far as possible with the scheme of Agricultural Research.

He also stressed that non-officials with the necessary knowledge on different aspects of Agricultural Research should be given suitable representation on the Research Council and on the Advisory Body in the interest of the purposes that are in view.

PROFESSOR S. R. Kashyap, Professor of Botany, Punjab University said :—" The question of the co-operation between the Agriculture Department and the Universities had been before the Science Faculty of the Panjab University for some time and had been referred to the Boards of Studies in the Sciences concerned. All the Boards had agreed that it was very desirable to have this co-operation between the two bodies and they were perfectly willing to co-operate. Our great requirements were the two following : --

(1) In order to tackle problems on a large scale it was necessary to have an experimental farm which we did not possess at present.
(2) In order to ensure continuity of work in investigations requiring some years for their completion it was necessary that Research Assistants be appointed for several years.

Our laboratories were well equipped for investigations of various kinds of Agricultural problems."

DR. GILBERT J. FOWLER, Bangalore, remarked that the problems of agriculture were becoming more and more bio-chemical and bio-physical, and afforded ample scope for research work which could be carried on in University laboratories. Such work would be of no less educational value than the researches on, *e.g*, pure organic chemistry, which now appeared to absorb the main energies of University laboratories. It would also possess the great advantage of bringing both staff and students more into touch with the outside world. At the same time the Universities would be doing a real service to agriculture in taking up researches on subjects which, while of great ultimate importance, demanded time and equipment which were not always at the disposal of the agricultural specialist.

MR. M. ALAM, Economic Botanist, Bihar, said :—Plant breeding is the most important branch of Agricultural Science and our Universities should help a good deal in this direction. Modern Plant-breeding is intimately related to the study of Genetics which forms the foundation on which the whole structure of Plant-breeding is built. At present the study of Genetics, especially the practical side, is hopelessly neglected in most Indian Universities. There is not a single University in India, as distinct from Agricultural institutions, where Genetics plays any important rôle. It is highly desirable that fundamental researches in Genetics, which fall under the realm of Pure Science be taken up there and at least a Readership in Genetics be instituted in some of our Universities. This would not only provide ample opportunities to the earnest workers in this line, who would then no more be condemned for not having an economic end in view, but would at the same time relieve the Agricultural Department from this extra responsibility which is really outside their jurisdiction. In many foreign countries such researches in Genetics are being carried out by University men and enormous amount of literature is accumulating every day, but in India there is hardly one single instance of this. Whatever little work on pure science of Genetics has so far been done in India, goes to the credit of the Agricultural Department.

DR. J. C. GHOSH, Professor of Chemistry, Dacca University, said :—" I feel that I should say a few words to remove any misunderstanding that may exist among the members of the Congress about the availability of research grant from the Imperial Council. From my own experience I find that the procedure is fairly simple. For example in the Dacca University, we agreed, in consultation with the Director of Agriculture, to carry out researches on the following subjects :—

(1) Mechanical Analysis of laterite soils with a view to finding out how the data obtained from such analysis are related to cultural conditions.
(2) The problem of nitrogen supply to rice plants.

The application for research grant was forwarded to the Secretary, Imperial Research Council, by the Registrar of the Dacca University about the middle of November and by the 3rd week of December, we received information that a research grant would be given us with effect from 1st of April. It is clear that there is no undue delay in considering applications."

PROFESSOR K. G. NAIK, Professor of Chemistry, Baroda, invited the attention of the Research Council to two points:—(1) That an extensive agricultural soil survey should be undertaken without delay by the Government of India, so that farmers may know what they can produce best on their soils which may be of a particular class and thus best suited to a particular kind of crop only, as this is most essential from a national standpoint; and further that the farmers should know, by an occasional examination of their soils, as to how they can replenish the decreased fertility of their soils. They should as well know the particular kind of manure which would best suit their soils and the particular crop they are growing. (2) In an advanced country, the national government would, according to the nature of their equipment (specially of the Departments of Botany, Bio-chemistry, Zoology, Entomology, etc.), ask the Universities to undertake agricultural research under various heads, in the farms (specially set aside by the Government), attached to and managed by the University. The activities of the Agricultural Department should only be confined to propaganda work whereby they should bring to the doors of the farmers the results of the successful researches carried out by the Universities. The Department should organise demonstrations at various centres, arrange exhibitions in central agricultural areas, run demonstration trains, educate the public by means of lectures, charts, and such other things, start Agricultural Associations, etc. At present the Agricultural Department is attempting too much and therefore the returns in the form of tangible results are not commensurate with the time and public money spent by it.

Besides these, Messrs. George Clarke (President, Agriculture Section), R. L. Sethi (Cawnpore), Rao Bahadur G. N. Rangaswamy Iyengar (Coimbatore), Drs. S. B. Singh (Meerut), T. Ekambaram (Madras), M. A. Sampathkumaran (Bangalore), B. N. Singh (Benares), Muzaffer (Punjab), S. Higginbotham (Naini, Allahabad), and S. K. Mukherji (Lucknow) took part in the discussion.

In winding up the discussion, the Chairman said that from the interesting discussion two points clearly emerged, namely, (1) that the Universities and other educational institutions were ready, to co-operate with the Council of Agricultural Research in research on agricultural problems; and (2) that research workers should not be overburdened with teaching and administrative work. In his opinion, it was not possible nor even desirable to divorce research work from teaching, and a certain amount of administrative work by the research workers was inevitable. He did not agree with the idea that the Council of Agricultural Research should suggest problems to individual workers. The best method would be that the workers themselves should select problems in which they are interested and submit schemes to the Agricultural Council. If the latter thought the scheme had any bearing on agriculture, they should subsidise the research worker by giving him technical assistance and money for meeting expenses in connection with the investigation in question.

The meeting dispersed at 1 P.M.

II. RICE.

A joint session of the Sections of Agriculture and Botany was held on Saturday, 4th January, 1930, at 11 A.M., to discuss the problems in connection with " Rice ". Prof. P. Parija was in the Chair. The discussion was opened by Prof. R. H. Dastur with the following remarks :—

The following aspects of the Physiology of the Rice plant have been studied :—

(1) The osmotic pressure of the roots and leaves of the Rice plant during the whole season of the plant, 1927.
(2) The suction pressure of the roots and leaves of the Rice plant during the whole season, 1928.
(3) The osmotic and suction pressures of the roots and leaves of the rice plant during the whole season, 1929.
(4) The respiration of seedlings grown in the dark, of different ages, and at different temperatures, varying from 29°C. to 36°C. 1928.
(5) The respiration of seedlings germinated in soil under normal conditions of different ages and at different temperatures varying from 30°C. to 40°C., 1929.
(6) The respiration of roots and leaves of the rice plant during the season, 1928.
(7) Transpiration measurements of the rice plant during the whole season, 1929.
(8) Absorption of SO_4, NH_4, and NO_3 ions from culture solutions at different stages of growth.
(9) Absorption of SO_4 and NH_4 ions from solutions of ammonium sulphate in different concentrations and at different stages of growth.
(10) Absorption of NO_3 ions from solutions of KNO_3 of different concentrations and at different stages of growth.
(11) The effect on osmotic pressure and suction pressure of rice seedlings in solutions of $(NH_4)_2SO_4$ of different concentrations.

The osmotic pressure was determined by the plasmolytic method as it was found more suitable and accurate than the plasmometric method of Hofler. The osmotic pressures at the root apex, root base, leaf base, and leaf apex were determined. An average of three readings was taken. The experimental error as calculated was negligible. Saccharose obtained from Mercks was used as the plasmolysing fluid. Solutions of concentration varying from ·05 to 1M were prepared. The sections were kept in the solutions from 30 to 40 minutes, in glass-stoppered bottles.

The osmotic pressure increases from the root apex towards the leaf apex. The pressure also increases in July, reaches its maximum in August and then begins to fall. In roots, it rises from 6.7 to 14 atmospheres, and then falls to 5 atmospheres. In the leaf from 10 to 18 atmospheres at the base and 12 to 24 at the apex. Manuring with ammonium sulphate caused an increase in the Osmotic pressure from 5 to 7 atms. in the roots and 17 to 19 atms. in the leaves

The suction pressure of the same organs was determined by the Ursprung and Blum method. In this case a measured strip of tissue was placed in solutions of different concentrations and the solution in which the strip did not show any change in length was taken as equivalent to the suction pressure of the tissue. The values of suction pressure are lower than the values of osmotic pressure for the same organs as expected. In roots, it fluctuates between 2 and 5 atmospheres and in the leaves from 7 to 10 at the base and 10 to 15 at the apex. Towards the end of the season the value of the suction pressure rises and an important point is noticed, *viz.*, that the suction pressure becomes equal to the osmotic pressure. This point is re-determined by making a series of fresh determinations of the osmotic and suction pressures of the different tissues side by side. In all cases they were found equal at the end of the season.

If the suction pressure be equal to the osmotic pressure, the wall pressure is zero, *i.e.* the cell walls lose their elasticity. If the cell walls lose their elasticity, it would not be possible to measure the suction pressure as there will not be any elongation or contraction of the strip of tissue. This is true as the % variations in the dimensions of the strip of tissue for a difference of ·15M decrease as the season advances and it becomes negligible at the end.

As the above determinations of osmotic and suction pressures were not made in the same season but in two different seasons of rice in 1927 and 1928 respectively, perhaps the results are not strictly comparable. In 1929, therefore, the measurements of osmotic and suction pressures were made simultaneously on the same day. The results obtained are of the same nature as in the previous years as the figures and graphs show.

The respiration of seedlings during early stages of germination is studied with a specially contrived apparatus. The seedlings were grown in the dark and the respiration of the seedlings after every 24 hours was measured up to the eighth day at 36 C. On the fifth day, the respiratory activity was maximum and then it began to fall continuously. Respiration was also measured at different temperatures of the seedlings at different stages and there also on the fifth day the respiration value was maximum.

The seedlings were then grown in the soil and in light and the same features were noticed. There was no difference in the respiratory activities of the seedlings grown in light or in dark.

The seedlings were kept on moist glass wool and glass beads and were watered with culture solution. When, however, a culture solution containing nitrogen in the form of ammonium sulphate was used, the rate of respiration showed a small rise.

The respiration of the roots and the leaves of the rice plant during the whole season was measured by the same apparatus. The respiratory activity was at its maximum in the second and third week of September, and then it began to fall in both cases.

Kellner showed that the rice plant grows well in the early stages when supplied with ammonium salts and in the later stages with nitrates, and Espino found that a culture solution containing monopotassium phosphate, $CaSO_4$, $MgSO_4$, and $(NH_4)_2SO_4$, and Fe phosphate was the best solution for the young rice plants. It was, therefore, undertaken to study the absorption of NH_4 and NO_3 ions during the early and adult stages of the rice plant. It was found that the absorption of ammonium ions decreases as the age of the plant increases and so also that of the SO_4 ions from culture solutions containing $(NH_4)_2SO_4$, and culture solutions containing $(NH_4)_2SO_4$ and KNO_3. The absorption of Nitrate ions is very little during the early stages but it increases as the age advances, and it is greatest just before the flowering period and during the flowering period. In pure ammonium sulphate solutions the absorption of NH_4 increases as the strength of the solution is decreased from $\frac{N}{200}$ to $\frac{N}{900}$ in the early stages but $\frac{N}{300}$ and $\frac{N}{400}$ are the best solutions because in solutions of strength the seedlings die very probably as the solution turns acid on account of the reason mentioned below.

The SO_4 from the same series of solutions is absorbed less and less as the strength of the solution decreases. So there is unequal absorption of NH_4 and SO_4 ions from each solution and the irregularity becomes greater as the strength of the solution is reduced. Hence the solution becomes more and more acid which has an injurious effect on the roots and therefore the seedlings die.

It is also determined what are the best strengths of solutions of $(NH_4)_2SO_4$ and KNO_3 at different stages of the plant growth.

In the discussion that followed the following points were emphasised :—

(1) The increase in the absorption of No_3 ions by the plants as the age increased may be only apparent and caused by the de-nitrification of nitrates to nitrites in the culture solutions. This is not probable as the culture solution was renewed every eight days and secondly if de-nitrification occurred within 8 days, the results should not show the increased absorptions of No_3 ions as the age increased and a subsequent decrease in the final stages of growth but should be regular.

(2) The plasmolytic method of measuring the osmotic pressure is not very accurate. It was pointed out that the plasmolytic method was more suitable and sufficiently accurate for the purpose than the plasmometric method of Höfler. (i) A large number of determinations could not be made with the plasmometric method every day. (ii) The average osmotic pressure of tissues was to be measured and not of individual cells. (iii) Both methods were tried and it was found that the differences between the values obtained were slight.

	Plasmolytic method.	Plasmometric method.	Difference.
Lead Sheath	11·66 Atmos	12·08 Atmos	+0·42
,,	11·66 ,,	11·3 ,,	−0·36
Mean	11·66	11·69	+0·03

The meeting terminated at 1 P.M.

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OFFICIAL.

The General Committee of the Indian Science Congress at its meeting held in Allahabad on the 7th January, 1930, adopted the following resolution of the Council which had been recommended by the Executive Committee.

"Resolved that a Sub-Committee of the following gentlemen be appointed to consider the alterations and additions to the present rules of the Indian Science Congress rendered necessary in the light of experience and to make definite proposals in connection therewith. The Sub-Committee shall submit their report to the Executive Committee by the end of August, 1930 :—

Sir C. V. Raman,	Dr. Baini Prasad,
Prof. J. N. Mukherji,	Mr. Johan van Manen,
Prof. H. C. Das Gupta,	Prof. S. P. Agharkar.

The Executive Committee is empowered to fill up vacancies that may arise in the Committee."

MATERIALS REGARDING A PROPOSED CONSTITUTION, INDIAN SCIENCE CONGRESS.

A meeting of the Executive Committee of the Indian Science Congress was held on Wednesday, the 14th August, 1929, at 5-30 P.M., in the Rooms of the Asiatic Society of Bengal.

Present:

SIR C. V. RAMAN, *in the Chair.*
DR. S. P. AGHARKAR.
MR. JOHAN VAN MANEN.

The present position in connection with a draft Constitution for the Science Congress was considered, as well as various replies and Memoranda received from some of the absent Members of the Executive Committee and Members of the Council.

It was resolved to print these letters together with previous documents and to circulate the complete material to the Members of the General Committee before the meeting of the next Congress, together with the following recommendation :—

The Executive Committee in view of the considerable diversity of opinion expressed in principle as well as detail, and further considering that the present constitution has, after all, actually worked efficiently and successfully, recommends that the question be not further considered for the present, but may be brought up again at any time in the future.

I. *Present Rules.*

RULES.

INDIAN SCIENCE CONGRESS.

I. The administrative work of the Congress shall be carried on by an Executive Committee, who shall submit such questions as they think desirable to a General Committee at its Annual Meeting or at a special meeting of which satisfactory notice shall be given.

II. The General Committee shall consist of all Full Members (*Vide Rule XI;*) who have attended three meetings (including that actually taking place at any time) and those members who have held office in the Congress. This Committee shall meet at least once at each Congress, usually in the middle of the meeting.

III. The Executive Committee shall consist of the President, the retiring President, the two General Secretaries, the Treasurer of the Asiatic Society of Bengal, the General Secretary of the Asiatic Society of Bengal, and three members elected by the General Committee at its Annual General Meeting. The Executive Committee shall have full powers to transact all business in case of need, notwithstanding any limitations herein laid down.

IV. The Council shall consist of the members of Executive Committee, of the Past Presidents resident in India and five other members appointed by the General Committee at its Annual Meeting.

The Council shall be consulted on matters of general scientific importance and policy.

V. The nomination of the President shall be made by the Executive Committee and submitted for confirmation to the General Committee.

VI. The Sectional Presidents shall be appointed by the Executive Committee.

(*Experience shows that there is not time for any other arrangement to work satisfactorily.*)

VII. The two General Secretaries shall be nominated by the Executive Committee and submitted to the General Committee for confirmation.

VII*a*. Each General Secretary shall hold office for five years from the date of his appointment, but shall be eligible for reappointment.

VIII. As long as the present relationship with the Asiatic Society of Bengal continues, the General Secretary and the Treasurer of that Society shall be members of the Executive Committee.

IX. The Local Secretary (or Secretaries) and the Local Committee for any meeting of the Congress shall be appointed by the Executive Committee.

X. The Local Secretary (or Secretaries) and the local Committee shall assist in making arrangements for the reception and entertainment of the visitors and for the distribution of letters at the meeting.

XI. There shall be three classes of members:—

(i) *Full members:* Annual subscription *Rupees ten.*
(ii) *Associate members:* Annual subscription *Rupees five.*
(iii) *Student members:* Annual subscription *Rupees two*

(Student members must be definitely certified by the Principal of their College as *bona fide* students.)

Only Full Members have the right of communicating papers to the Congress and they receive free of charge all publications. Associate and Student Members have the right of reading papers before the Congress provided they have been communicated by a Full Member.

[1] XII. The following procedure is to be adopted for making any additions or alterations in the above rules:—

(*a*) Proposals for additions to and alterations in the existing rules are to be sent to the General Secretary at least two months before the meeting of the General Committee at which they are to be moved. The General Secretary, on receipt of such proposals, shall circulate them to all members of the General Committee who paid their annual subscription at the last session of the Congress.

(*b*) Any amendments to the proposals shall be sent to the General Secretary at least a fortnight before the meeting of the General Committee.

[1] XIII. The proposals with amendments shall be brought up before the meeting of the General Committee (with remarks of the Executive Committee, if any) and declared carried, if accepted by a two-thirds majority of those present at the meeting.

SECTIONAL COMMITTEES.

XIV. (*a*) The Sectional Committees shall consist of not more than three members who shall be:—

(1) The President of the Section (convener).
(2) The retiring President of the Section.
(3) One member elected by the General Committee at its Annual General Meeting.

(*b*) The Sectional Committee shall arrange and referee all papers to be read before the Section.

(*c*) The Sectional Committee shall have power to fill vacancies during the year of their appointment.

(*d*) The Sectional Committee shall nominate annually a President for the section for the consideration of the Executive Committee.

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[1] Added at the Bangalore Meeting, 1924.

PAPERS.

[1] XV. (*a*) An abstract of any paper to be read at the Indian Science Congress must be submitted to the General Secretary or the President of the Section concerned not later than the 15th of October. [This will enable abstracts to be printed and circulated to members before leaving their Stations to attend the Congress.]

(*b*) All papers which are to be read must be refereed by the Sectional Committee or by some person appointed by them, the decision to be final and all reports confidential. In deciding whether a paper should be read the Sectional Committees will take into consideration the question whether the paper has been previously published.

(*c*) Each paper must be accompanied by an abstract and if the paper be of great length, it should be summarised.

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[1] Amended at the Benares Meeting, 1925.

II. *Draft Constitution, Indian Science Congress, submitted to the 16th Indian Science Congress, drawn up in pursuance of a resolution of a meeting of the Executive Committee, Indian Science Congress, held on Thursday, the 20th December, 1928.*

The draft constitution now submitted refrains as far as possible from the introduction of any new elements, and attempts only to embody the existing written rules and unwritten practices or conventions into one consistent whole.

It is our opinion that the Science Congress is a growing organisation, still in need of appreciable expansion and development requiring at present a large measure of flexibility.

It does not seem to us at the present stage of its development either practicable or desirable to legislate in detail and to prescribe administrative processes which the body at present cannot yet apply.

What is attempted is to set down the principles upon which in the future such detailed legislation should be based and the direction in which it should develop.

As the question of a constitution for the proposed Association can be approached from different angles of vision, it has been thought advisable to place before the Executive Committee two drafts of certain sections which differ to a certain extent in principle and detail. As an amalgamation of both drafts would lead to a hybrid result we decided to place them independently side by side before the Executive Committee for consideration on their respective merits.

In addition, a proposal was made to proceed at once to a more detailed codification of prescriptions with regard to the working of the sections of the Congress and this part of the draft may be considered independently, either as a matter to be incorporated into the Constitution or to be relegated to Bye-laws.

Further, we recommend that any new constitution should be preceded by a short and general preamble regarding the relation between the Indian Science Congress and the Asiatic Society of Bengal, (somewhat on the lines of the one drafted and now submitted) to prevent any possible misunderstanding in the minds of members of either body.

With these remarks we submit the drafts referred to as constituting a suitable basis for discussion.

CALCUTTA,
20th December, 1928.

S. P. AGHARKAR.
JOHAN VAN MANEN.

CONSTITUTION.

SECTION I.

Title.

The name and title of this organisation is "The Indian Science Congress Association".

SECTION 2.

Objects.

The objects for which this Association established are:—

(1) The promotion of Science in India.
(2) The annual holding of an Indian Science Congress.
(3) The arrangement for publication of Proceedings of the Congress.
(4) The holding and management of all funds raised by or entrusted to the Association for the above objects.
(5) The acquisition of any rights or privileges necessary or convenient for the purposes of the Association.
(6) The management, development, improvement, and sale of all and any parts of the property of the Association.
(7) The doing of all such things as are incidental or conducive to the attainment of the above objects or any of them.

SECTION 3.

Members.

The Association shall consist of Ordinary Members and of such other classes of members as may be instituted from time to time.

Ordinary Members, the number of whom shall be unlimited, shall be those persons who shall have applied for membership in writing, signed an undertaking to be bound by the Constitution and Bye-laws of the Association, and shall have paid their annual subscription in respect of the current year or in lieu thereof a compounding fee for the payment of all future annual subscriptions, as provided for in these Rules.

Ordinary Members, who shall have compounded for the payment of all future annual subscriptions, shall be entitled Life Members.

No technical qualifications shall be required for Membership.

Sex, race, nationality, or creed shall be no bar to membership.

It shall be competent to the Council at any time to institute classes of other than Ordinary Members provided always that the position of such classes of Members and the circumstances, conditions, and rights of their membership, including the subscription due by them, shall be defined in Bye-laws and further provided that the institution of such classes of members shall not become effective unless such Bye-laws concerning them shall have themselves become effective in conformity with the prescriptions of section 9 on Bye-laws.

SECTION 4.

Rights and privileges of Members.

Ordinary Members in good standing of over two years' uninterrupted membership shall have the right to attend and vote at the Annual General Meeting and any other General Meeting of the Association.

Ordinary Members shall have the right to attend the Congress subject to any limitation which may be determined from time to time by the Council, the Local Congress Committee, or any Sectional Committee.

Ordinary Members shall have the right to communicate papers to the Congress subject to any date-limit and any other limitation duly fixed for the acceptance of papers.

Ordinary Members shall receive gratis one copy of the Proceedings of each Congress held during the term of their Membership.

Ordinary Members shall receive the advance notifications issued by or on behalf of the Association concerning the Congress.

SECTION 5.

Subscriptions.

Ordinary Members shall pay an annual subscription of ten rupees provided always that they shall be entitled at any time to compound for the payment of all future annual subscriptions by the single payment of a sum of one hundred rupees.

Subscriptions obligatory on other than Ordinary Members shall be prescribed in Bye-laws concerning any such classes of members when instituted.

Annual subscriptions shall be due in advance on the first day of the financial year of the Association.

SECTION 6.

Management, Officers, and Organs.

The direction and management of the affairs of the Association shall be vested in a Council.

The Council shall consist of a President, a General Secretary, a Congress Secretary, the General Secretary of the Asiatic Society of Bengal for the time being, a Treasurer who shall be the Treasurer of the Asiatic Society of Bengal for the time being, the previous year's President, and three additional Members.

At meetings of the Council three members shall form a quorum.

The President, the General Secretary, and the Congress Secretary shall be nominated by the Council and these nominations shall be submitted for confirmation by a simple majority vote of the Members voting at the Annual Meeting of the Association.

The three additional Members shall be elected by a simple majority vote of the Members voting at the Annual Meeting of the Association.

Transfer of functions under this section shall take place on the 1st day of the month following on that in which the Annual Congress comes to a close provided always that if for any reason the Officers and Members of the Council should not be appointed for the ensuing year in the Annual General Meeting of the Association, the Officers and Members of the Council elected or co-opted during the previous year shall continue to hold office together with the *ex-officio* members until their successors shall have been duly elected.

The Council shall have power to fill all vacancies arising in their midst after the close of the Annual General Meeting.

In case of sudden vacation of office by the Congress Secretary of the Association, the General Secretary of the Asiatic Society of Bengal for the time being shall immediately assume the former's duties and exercise his functions, until the Council shall have appointed a new Congress Secretary.

The General Secretary of the Association shall be the Executive Officer of the Council for all affairs not directly regarding the Congress.

The Congress Secretary of the Association shall be the Executive Officer of the Council for all affairs directly regarding the Congress.

The President, the General Secretary, and the Congress Secretary of the Association shall be *ex-officio* Members of all bodies within the Congress.

The Council, and all Officers and Organs of the Association shall, within their respective spheres of action, have full power to act in any matter not limited by or provided for in these Rules.

In all bodies within the Congress the Chairman shall have a casting vote and the Chairman's decision on any point not provided for in these Rules shall be final.

All organs of the Association shall act in co-operation but shall be, in so far as not limited by these Rules, autonomous within their respective spheres of action.

No person shall be entitled to hold office in the Association unless he be a Member.

SECTION 7.

Advisory Board.

There shall be an Advisory board which shall consist of the Members of Council, of the Past Presidents of the Association, resident or present in India, and of the Presidents of Sections of the Congress for the current and the two preceding years.

The Council shall consult the Advisory Board in matters of general policy and scientific importance.

SECTION 8.

General Meeting.

The Association shall annually hold an Ordinary General Meeting which shall coincide with the Annual Congress.

The Council may at any time convene a special General Meeting of the Association provided due notice be sent out to the members of the Association one clear month prior to the date fixed for the meeting.

The Council may submit any question to any special General Meeting of the Association, except those questions provided for in Section 12, provided due notice of such question be sent out to the members of the Association one clear month prior to the date fixed for the meeting.

For Ordinary Members the right of attendance and voting at any General Meeting shall be limited to those who have completed two uninterrupted years of membership.

At special General Meetings of the Association twenty-five members shall form a quorum.

SECTION 9.

Bye-laws.

The Council shall from time to time frame, repeal, or alter Bye-laws, and submit these Bye-laws, so framed or altered, or the repeal of such Bye-laws, for confirmation to the Ordinary Annual General Meeting.

Bye-laws thus framed or altered, or such repeal of Bye-laws, so submitted, shall become effective if confirmed by a simple majority vote of the members voting at the Annual Meeting of the Association.

Ordinary Members may propose to Council the framing, alteration or repeal of Bye-laws, provided that any such private proposal be communicated by the proposing Ordinary Member to the General Secretary and reach him by the end of July.

Any such private proposal shall be communicated by the General Secretary to all Ordinary Members before the end of September.

Ordinary Members may propose to Council amendments to proposals to frame, alter, or repeal Bye-laws, provided that any such private amendment be communicated by the proposing Ordinary Member to the General Secretary and reach him by the end of October.

Any such private amendments shall be communicated by the General Secretary to all Ordinary Members before the 15th of November.

Any proposal or amendment to such proposals submitted by Ordinary Members shall be placed before the Annual Meeting of the Association with the remarks, if any, of the Council.

The Bye-laws shall amongst others, prescribe:—

(*a*) **With regard to Membership.**

(1) Formalities, conditions, and restrictions in respect of admission to membership.

(2) Provisions for exclusion and expulsion from membership.

(*b*) **With regard to Funds.**

(1) Rules for the audit of the Funds of the Association.
(2) Rules in regard of any Endowment Fund.

(*c*) **With regard to the Congress.**

(1) A date limit for the acceptance of papers to be placed before the Congress.
(2) A date limit for the acceptance of copy to be incorporated in the Proceedings of the Congress.
(3) Limitation of the number of papers that may be submitted by any one person at any Session of the Congress.
(4) Rules with regard to the constitution and working of the Sectional Committees of the Congress.
(5) Rules regarding participation in the Congress by other than Association Members.
(6) Provisions with regard to late registration for participation in the Congress by other than Association Members.

(*d*) **With regard to new permanent or regular activities.**

(1) Rules for any permanent or regular activity of the Association under the constitution other than provided for in these Rules.

SECTION 10.

Congress.

The general preparations and arrangements for any Congress shall be left to the Council.

The local preparations and arrangements for any Congress shall be left to a local Congress Committee.

The local Congress Committee shall have a Secretary or Secretaries who shall be appointed by the Council.

The local Congress Committee shall be appointed by the Council and shall, after having been appointed, have power to co-opt members and to appoint its own officers other than Secretaries, and Sub-Committees.

The local Congress Committee shall amongst others make arrangements for the reception and entertainment of Members, and for the distribution of papers and letters to Members during the session of the Congress.

The local Congress Committee shall act in consultation and co-operation with the Council through the Congress Secretary.

The Congress shall be divided into Sections.

The Congress Sections shall be managed by Sectional Committees.

The Council shall have power to fill any vacancies arising in Sectional Committees subsequent to their appointment and to replace the previous year's President of the Section by someone else in the case of the former vacating his Sectional Committee Membership.

Each Sectional Committee shall nominate a candidate to be the Section's President in the next Congress and submit this nomination to the Council for consideration.

The preparation, printing, publication, distribution, and sale of the Proceedings of the Congress shall be left to the Asiatic Society of Bengal.

The office administration of the Association, when not in Congressional Session, shall be left to the Asiatic Society of Bengal.

SECTION 11.

Funds and Finance.

The financial year of the Association shall begin from 1st of July.

The funds of the Association and any funds of any Local Congress Committee raised by voluntary donations by the said Committee for local purposes shall remain separate and the ownership of such funds shall vest solely in the Association and the Local Congress Committee respectively.

The Local Committee shall have no power to incur without previous sanction of the Council any expenditure chargeable to the funds of the Association.

There shall be a Permanent Endowment Fund of the Association made up by such contributions as the Council may from time to time transfer to it from the liquid assets of the Association and by such contributions as may be received and accepted by the Council for the increase of the Fund.

It shall not be competent to the Council or to any of the Officers of the Association or to any Committee or Body within the Association to sell or alienate the said Fund or any portion of it without first recommending such sale or alienation to the General Meetings of the Association to be voted upon in the said meetings subject to rules of voting similar to those prescribed in section 12 for any revision of the Constitution of the Association.

Any and all income derived from investment of any part of the Permanent Endowment Fund shall be utilisable income of the Association.

SECTION 12.

Revision.

The Association may add to, repeal, or alter any part of this constitution in any Annual General Meeting of the Association provided that three-fourths of the Members voting at such Meeting vote in favour of such addition, repeal, or alteration, and further provided that such addition, repeal, or alteration shall only become effective after confirmation by a simple majority vote of the Members voting at the next Annual Meeting of the Association.

(Appendix 1.)

SUGGESTED PREAMBLE.

The Indian Science Congress Association is the successor of the Annual Indian Science Congress which was started in Calcutta in 1914 under the auspices of the Asiatic Society of Bengal by which it has since been materially assisted in its work.

The relationship between the two bodies has hitherto been one of voluntary co-operation without subordination, and as long as this relationship remains recognised the Asiatic Society of Bengal is prepared to continue its assistance and to carry on the office administration of the Association, during the period when the Indian Science Congress is not in session, without claim to any control over the affairs of the Indian Science Congress Association.

(Appendix 2.)

THE WORK OF THE SECTIONS.

1. The scientific work of the Association shall be transacted under such Sections as shall be constituted from time to time by the General Committee. It shall be competent for any Section, if authorised by the Council for the time being, to form a sub-section for the purpose of dealing separately with any group of communications addressed to that Section.

2. There shall be in each Section a President, Vice-President, and at least two Secretaries. They shall be appointed by the Council, for each Annual Meeting in advance, and shall act as officers of the Section from the date of their appointment until the appointment of their successors in office for the ensuing Annual Meeting. Of the Secretaries one shall act as the Recorder of the Section and one at least shall be resident in the locality where the Annual Meeting is held.

3. The work of each Section shall be conducted by a Sectional Committee constituted as follows—

(i) The Officers of the Section during their term of office.
(ii) All past presidents of that Section resident in India.
(iii) Such other members of the Association present at any annual meeting, as the Sectional Committee thus constituted, may co-opt for the period of the meeting;

provided always that

(*a*) any member of the Association who has served on the Committee in any previous year, and who has intimated his desire to be present at the annual meeting shall be entitled to attend the first meeting of that Committee.

4. The chief executive officers of the Section shall be the President and the Recorder. They shall have power to act on behalf of the Sectional Committee in any matter of urgency which cannot be brought before the consideration of the Sectional Committee; and they shall report such action to the Sectional Committee at its next meeting.

The President shall preside over all the Meetings of the Sectional Committee or of the Section His ruling shall be absolute on all points of order that may arise.

The Recorder shall be responsible for the punctual transmission to the General Secretary of the programme of his Section, of the recommendations adopted by the Sectional Committee, of the printed abstracts, reports, etc., concerning the proceedings of the Section at the Annual Meeting and for the correspondence and minutes of the Sectional Committee.

Each Sectional Committee shall meet daily, unless otherwise determined, during the Annual Meeting: to co-opt members, to complete arrangements for the next day, and to take into consideration any suggestions for the advancement of Science that may be made during the work of the Section.

III. *Alternative suggestions by Dr. S. P. Agharkar, with correspondence.*

DEAR VAN MANEN,

I have gone over the Congress Constitution once more and have tried to correlate the various parts or section as drafted by you and the alternatives as framed by me, and find that

(i) We are agreed on the report and the preamble.

(ii) We both wish to retain sections 1 and 2 as drafted by you with the additions and alterations made by the Executive Committee.

(iii) My section on membership is alternative to your sections 3 (members), 4 (rights and privileges of members) and 5 (subscriptions). I think you will agree with me in holding that one comprehensive section is better than 3 separate ones dealing with aspects of the same.

(iv) My sections on Council, General Committee, and President and General Officers are alternative to your Section (6) Management, officers, and organs. You will see that the General Committee is a necessity if we want the Association to work. Transferring the power of the existing General Committee to a General Meeting of all members (=all full members of the Congress) will, in a few years, create serious difficulties.

I have purposely left vague the functions of the General Secretaries, as that is best left to internal arrangement, instead of being settled by statute.

I really think that you may perhaps agree to my draft in this connection.

(v) I enclose an amended Section on Advisory Board or Committee of Recommendations defining its functions and manner of procedure.

(vi) Section on "The Annual Meeting" or Congress of my draft is alternative to your Sections 8 and 10. Section 8 is rendered unnecessary as this function will be performed by the General Committee proposed in my draft.

Your Section 10 is equal to my "The Annual Meeting" and "the working of the Sections".

(vii) "Funds and finance" is alternative to mine.

(viii) Your Section (12) Revision. I am proposing an alternative which is much simpler but is more effective when combined with my Section on Committee of Recommendations.

S. P. AGHARKAR.

CALCUTTA,

22nd December, 1928.

(ALTERNATIVE SUGGESTIONS.)

Sections 3, 4, and 5.

MEMBERSHIP.

1. No technical qualification shall be required on the part of an applicant for admission as a member of the Indian Science Congress Association; but the Council is empowered, in the case of special circumstances arising, to impose suitable conditions and restrictions in this respect.

2. Every person admitted as member shall conform to the Rules and Regulations of the Association, and for any infringement thereof shall be liable to exclusion by the Council, who have also authority, if they think necessary, to withhold from any person the privilege of attending any Annual Meeting (Congress Session) or to cancel a ticket of admission already issued.

3. **Members :—**

The Association shall consist of (*a*) Life Members, (*b*) Ordinary Members, (*c*) Session Members, (*d*) Student Members, and of such other classes of members as may be instituted from time to time.

(*a*) Every Life Member shall pay, on admission, the sum of Rupees one hundred.

(*b*) Ordinary Member (the number of whom shall be unlimited) shall pay, the sum of Rs. 10 on admission and the sum of Rs. 10 in every subsequent year.

(*c*) Session Members (whose numbers shall be unlimited) shall pay, the sum of Rs. 10 on admission.

(*d*) Student Members, duly certified as *bona fide* students by the heads of their institutions, shall pay, on admission, a sum of Rs. 2. Their number shall be unlimited and they shall not be entitled to any privilege beyond attendance at the Annual Meeting.

4. Subscriptions are payable at or before the Annual Meeting. Ordinary Members not attending the Annual Meeting may make payment at any time before the close of the financial year on June 30th of the following year.

The Governing Body of the Association shall be a General Committee, constituted as hereinafter set forth; and its affairs shall be directed by a Council and conducted by General Officers appointed by that Committee.

Section 6.

COUNCIL.

1. The Council shall consist of Ex-officio Members and of Ordinary Members elected annually by the General Committee.

(*i*) **The Ex-officio Members are :—**

Past Presidents of the Association (Congress) resident in India, the President and Sectional Presidents of the year, the President and Sectional Presidents of the past year, past and present General Treasurers resident in India, past and present General Secretaries resident in India, Local Treasurer and Local Secretaries for the ensuing Annual Meeting; and the General Secretary of the Asiatic Society of Bengal (for the time being).

(*ii*) **The Ordinary Members** shall not exceed ten in number. Of these not more than six shall have served on the Council as Ordinary Members in the previous year.

2. The Council shall have power to act, in the name and on behalf of the Association, in all matters which do not conflict with the functions of the General Committee.

In the interval between two Annual Meetings, the Council shall manage the affairs of the Association and may fill up vacancies among General and other Officers, until the next Annual Meeting.

The Council shall hold such meetings as they may think fit, and shall in any case meet on the first day of the Annual Meeting, in order to complete and adopt the Annual Report, and to consider other matters to be brought before the General Committee.

The Council shall nominate for election by the General Committee, at each Annual Meeting, a President and General Officers of the Association.

The Council shall have power to appoint and dismiss such paid officers as may be necessary to carry on the work of the Association, on such terms as they may from time to time determine.

3. Election to the Council shall take place at the same time as that of the Officers of the Association.

The Council shall submit to the General Committee, in their annual report, the names of eight members of the Association whom they recommend for election as Members of Council.

Two members shall be elected by the General Committee, without nomination by the Council; and this election shall be at the same meeting as that at which the election of the other members of the Council takes place.

Any member of the General Committee may propose another member thereof for election as one of these two Members of Council and if only two are so proposed, they shall be declared elected; but, if more than two are so proposed, the election shall be by show of hands, unless five members at least require it to be by ballot.

Section 6 (Separately).

THE PRESIDENT AND GENERAL OFFICERS.

1. The President assumes office from the close of the Annual Meeting in which his nomination is confirmed by the General Committee. He shall deliver a Presidential Address at the next Annual Meeting at the conclusion of which meeting he lays down office.

The President shall preside at all meetings of the Association and of its Council which he attends in his capacity as President. In his absence he shall be represented by one of the past Presidents of the Association or by the Senior Sectional President present.

2. The General Officers of the Association are:

The General Treasurer and the General Secretaries.

The Treasurer of the Asiatic Society of Bengal for the time being shall be the General Treasurer of the Association.

It shall be competent for the General Officers to act, in the name of the Association, in any matter of urgency which in their judgment cannot be brought under the consideration of the Council; and they shall report such action to the Council at the next meeting.

3. The General Treasurer shall be responsible to the General Committee and the Council for the financial administration of the Association.

4. The General Secretaries shall control the general organisation and the general administration and shall be responsible to the General Committee for conducting correspondence and for the general routine work of the Association, excepting that which relates to finance and that which relates to the publication of the Annual Proceedings.

The preparation, printing, publication, distribution, and sale of the Proceedings of the Annual Congress Meeting shall be left to the Asiatic Society of Bengal.

Section 6 (Separately).

GENERAL COMMITTEE.

1. The General Committee shall be constituted of the following persons:—

(i) **Permanent Members:**

(*a*) Past and present Members of the Council, Past and present Presidents of Sections.

(*b*) Life Members.

(ii) **Temporary Members:**

(*a*) Vice-Presidents and Secretaries of the Sections.

(*b*) Honorary Corresponding Members, foreign representatives and other persons specially invited or nominated by the Council or General Officers.

(*c*) Ordinary Members who have been Full Members of the Indian Science Congress from a date prior to 1928 without intermission or are of 3 years' standing.

(*d*) Session Members who have been Full Members of the Indian Science Congress without intermission from a date prior to 1928 and continue to do so.

2. The decision of the Council on the qualifications and claims of any Member of the Association to be placed on the General Committee shall be final.

Claims for admission as a Permanent Member must be lodged with the Assistant Secretary at least one month before the Annual Meeting.

Claims for admission as a Temporary Member may be sent to the Assistant Secretary at any time before or during the Annual General Meeting.

3. The General Committee shall meet twice at least during every Annual Meeting. In the interval between two Annual Meetings, it shall be competent for the Council at any time to summon a meeting of the General Committee.

4. The General Committee shall

(i) Receive and consider the report of the Council.
(ii) Determine the place of the Annual Meeting not less than two years in advance.
(iii) Determine the date of the next Annual Meeting.
(iv) Elect the President, Local Treasurer, and Local Secretaries for the next Annual Meeting.
(v) Elect Ordinary Members of the Council.
(vi) Appoint the General Officers.
(vii) Receive any notice of motion for the next Annual Meeting.

Section 7.

ADVISORY BOARD.

1. The Ex-officio Members of the Advisory Board are the President of the Association, the President of each Section of the Annual Meeting, the General Secretaries, the General Treasurer, and the Presidents of former years.

An Ordinary Member of the Committee for each Section shall be nominated by the Committee of that Section. If the President of a Section be unable to attend a Meeting of the Advisory Board, the Sectional Committee may appoint the Vice-President, or some other Member of the Committee, to attend in his place due notice of such appointment being sent to the General Secretary.

2. Every resolution on a scientific subject which may be submitted to the Association by any Sectional Committee, or otherwise than by the Council of the Association, shall be submitted to the Advisory Board. If the Advisory Board approve such recommendation, they shall transmit it to the General Committee; and no recommendation shall be considered by the General Committee that is not so transmitted.

Every recommendation adopted by the General Committee shall, if it involve action on the part of the Association, be transmitted to the Council; and the Council shall take such action as may be needful to give effect to it, and shall report to the General Committee not later than the next Annual Meeting.

Every proposal for establishing a new Section or Sub-section, for altering the title of a Section, or for any other change in the constitutional forms or fundamental rules of the Association, shall be referred to the Advisory Board for their consideration and report.

3. The Advisory Board shall assemble, for the despatch of business, on the first day of the Annual Meeting, and, if necessary, on the following day. Their report must be submitted to the General Committee on the last day of the Annual Meeting.

Sections 8 and 10.

CONGRESS.

The Annual Meeting.

Local Committee shall be formed to assist the General Officers (Congress Secretaries) in making arrangements for the **Annual Congress Meeting** and shall have power to add to their number.

The **Council** shall appoint, on the recommendation of the Local Reception or Executive Committee for the ensuing **Annual Meeting**, a Local Treasurer or Treasurers and two or more Local Congress Secretaries, who shall rank as officers of the Association and shall consult with the General Officers as to the local arrangements necessary for the conduct of the meeting. The local Treasurer may be empowered to enrol Members and to receive subscriptions on behalf of the Association.

The Local Committees and Sub-Committees shall undertake the local organisation and shall have power to act in the name of the Association in all matters pertaining to the local arrangements for the Annual Meeting other than the work of the Sections.

Section 11.

FUNDS AND FINANCE.

1. The General Treasurer shall receive and acknowledge all sums of money paid to the Association. He shall submit at each meeting of the Council an interim statement of his Accounts; and after June 30th in each year, he shall prepare and submit to the General Committee a balance-sheet of the Funds of the Association.

2. The Accounts of the Association shall be audited annually by Auditors appointed by the General Committee.

3. The General Treasurer shall make all ordinary payments authorised by the General Committee or by the Council.

4. The General Treasurer is empowered to draw on the account of the Association and to invest on its behalf, part or all of the balance standing at any time to the credit of the Association in the Imperial Bank of India, in any temporary investment and to change, sell, or otherwise deal with such temporary investment as may seem to him desirable.

Section 12.

AMENDMENTS AND NEW RULES.

Any alterations in the Rules, and any amendments, or new Rules that may be proposed by the Council or individual Members shall be notified to the General Committee on the first day of the Annual Meeting, and referred forthwith to the Committee of Recommendations, and on the report of that Committee shall be submitted for approval at the last meeting of the General Committee.

No. 3574. *25th December,* 1928.

DEAR AGHARKAR,

Your covering letter accompanying your alternative draftings of certain sections of the Proposed Constitution for the Indian Science Congress Association.

I observe that the main draft is written from a point of view which aims exclusively at definition of the essential frame-work and to deal only with general principles of the structure.

All details are in accordance with this view point relegated to Bye-laws which can be fairly easily built up, extended or modified from year to year as the Association grows in needs and resources, and as experience demands.

The actual details (not the general principles) should according to this system be in Bye-laws, open to infinite expansion as occasion demands, and consideration of them can be taken up one by one at any time.

Such details have therefore been eliminated from this Constitution.

At this present stage the main draft only deals with the mainsprings of action, of which the results can flow and develop naturally in course of time.

The Constitution should of course leave full scope for healthy development and not bind or restrict in any way.

Yours sincerely,
JOHAN VAN MANEN.

DR. S. P. AGHARKAR,
35, Ballygunge Circular Road,
Calcutta.

IV. *Memoranda, Opinions and Correspondence of Members of the Executive Committee and of the Council.*

1. *A. Howard.*

INSTITUTE OF PLANT INDUSTRY, INDORE, CENTRAL INDIA.

Director :
A. HOWARD, C.I.E., M.A.

28th February, 1929.

DEAR DR. AGHARKAR,

Your letter of January 1929 on the proposed constitution for the Indian Science Congress. I have carefully studied the draft constitution and the existing arrangements and have come to the conclusion that the present rules are all that is really necessary and that the adoption of a formal constitution at this stage would not be in the best interests of the Congress.

In considering this matter I should like to draw attention to the principles of organisation on which the best centres of research in Europe and America have developed. In these, it has always been recognised that the essential act in the organisation of any form of creative work is the selection of the man or woman who has to do work. Nothing else matters very much. After the agents have been chosen and the means have been provided, the best service the rank and file can render is to efface themselves as rapidly and as completely as possible. Proceeding on these well tried principles, the best method of running the Congress will be to take the greatest possible care in filling any vacancies which arise so that the Executive can automatically renew its life. If this is done there will be no need for the exercise of the safeguards for preventing abuses which the existing rules already provide. We seem to possess the ideal constitution already and in my opinion we should be well advised to let well alone. Should, however, the Congress adopt a formal constitution the only result I can see will be a series of profitless discussions before the rules are drawn up followed by the continual hampering of the Executive. It is also very probable that we shall lose the valuable support of the Asiatic Society of Bengal. We can hardly expect men of the stamp of Dr. Van Manen and the Treasurer of the Society to go on working for the Congress unless they are given a reasonably free hand.

Yours sincerely,
A. HOWARD.

PROF. S. P. AGHARKAR, M.A.,
35, Ballygunge Circular Road,
Calcutta.

2. *M. O. Forster.*

M. O. FORSTER,
Indian Institute of Science, Bangalore.

DEAR PROFESSOR,

I have spent much time cogitating over the 'draft constitution', and although I recognise the care and ability devoted to it by you and Dr. Van Manen, I much prefer the existing rules, for reasons given in the accompanying remarks.

To save you trouble, I am sending a copy to Dr. Raman and to Dr. Norris.

PROF. S. P. AGHARKAR.
12*th March*, 1929.

Yours sincerely,
M. O. FORSTER.

Observations on the Draft Constitution.

Unless the draft Constitution is brought forward in compliance with a general and responsible demand, of which I myself have heard nothing, it seems to me that Professor Agharkar and Dr. Van Manen have been given much unnecessary trouble. Although I have the honour to be a past President of the Indian Science Congress, I heard the first whisper of any proposal to change the name and to have a written constitution only one hour before the meeting of the General Committee at which the printed draft was to be received, on 4th January, 1929. From this, I conclude that there does not exist any widespread eagerness for a change of name, or for a written constitution.

The Indian Science Congress has a record of increasing prestige and value to the cause of science in India. Its inception and growth reflect great credit on its first Honorary Secretaries and their successors. Changing its name appears to me deplorable and purposeless: as deplorable and purposeless in fact as I should regard a proposal to change the name of the Royal Society or the Asiatic Society of Bengal.

This highly creditable and growing performance of the Indian Science Congress has been achieved by entrusting the management to a few wisely selected and enthusiastic officers, who have been hampered as little as possible by rules and regulations. The great and only purpose of the organisation is to hold an Annual Congress for discussing matters of common scientific interest, consolidating scientific friendships and making new ones. At such a congress, all the time spent in arguments on rules and procedure is relatively wasted time, and the proposed constitution, even if ultimately brought within manageable and consistent proportions, can easily be turned by contentious minds to a mere machine for fruitless debate.

In the narrow time-limits of a Congress, when some of the Sections are already starved of opportunity for discussing researches—there were 161 abstracts of papers in the Chemistry Section this year—the various officers would be supermen to escape contravening some trifling little clause, or even over-looking a major provision, of the proposed constitutions; and thus opening the flood-gates of purposeless argument.

As I consider the present rules to be adequate, most of the clauses of the draft constitution appear to me almost entirely superfluous, and certainly make more difficult the task of ascertaining the proposed form of management, which is the most important aspect of any legislation, and which is quite easy to recognise in the present rules.

The proposed form of management appears to be reached on page 5, under Section 6, from which I gather that the present Executive Committee is to be called the Council, the present Council is to be called the Advisory Board and the present General Committee seems nominally to disappear, although it is recognisable under six different names, the 'Annual Meeting' (pages 5, 7, 10, and 11), the 'Annual General Meeting' (pages 5 and 10), an 'Ordinary General Meeting' (page 6), any 'General Meeting' (page 7), the 'Ordinary Annual General Meeting' (page 7) and any 'Annual Meeting (Congress Session)' (page 10). This multiplicity of names is regrettable, and needs attention. Furthermore, the word 'Organs', which is new to me in this connection, needs definition, especially as on page 6 it is stated that "All organs of the Association shall act in co-operation but shall be, in so far as not limited by these Rules, autonomous within their respective spheres of action". I have not the faintest idea what this means, and it is a common experience that a meaningless clause is often found extensible to almost any meaning. If there are any spirits of discord within the Congress, this clause alone would provide a splendid banquet for their propensities.

The draft constitution first presented does not appear to have altered the management very much except in name; but the alternative section 6 (page 11) appears to change it fundamentally because it makes the Council a very large body, which is to "have power to act, in the name and on behalf of the Association, in all matters which do not conflict with the functions of the General Committee". This "General Committee" previously entitled the 'Governing Body of the Association' is later (page 13) constituted of Permanent Members and Temporary Members, and is a still larger body, comprising "Session members who have been full members of the Indian Science Congress without intermission from a date prior to 1928 and continue to" be such members. Thus the Governing Body becomes a mass of (possibly half) the members of the Congress, of whom the majority may be presumed to have had no administrative experience connected with the Congress.

Although I have spent much time in trying to understand the 'Constitution', the two foregoing paragraphs may show a complete misapprehension of the framers' intentions. If so, what is likely to be the confusion arising when the 'Constitution' comes before the general body for discussion and ultimate acceptance? If on the other hand, I have understood them aright, the conflict of opinion revealed by the alternative texts offers, in my judgment, ample warning to the Executive Committee to leave well alone.

I earnestly hope, therefore, that the Executive Committee, while warmly and sincerely thanking Professor Agharkar and Dr. Van Manen for the patience and industry shown in their preparations of a draft constitution, may be pleased to suspend action upon it.

10*th March,* 1929. M. O. FORSTER.

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3. *H. C. Das Gupta.*

PRESIDENCY COLLEGE,
CALCUTTA.
25*th March,* 1929.

MY DEAR AGHARKAR,

I have carefully gone through the Draft Constitution you so very kindly forwarded to me in January last. I have proposed some additions and alterations which are sent herewith. One important change I find in the name of the Organisation. You have called the whole Organisation Indian Science Congress Association. I do not know if there is any legal necessity for the use of word Association. If there is no such necessity, I would like to use the expression with which we have been familiar for the last 16 years and not the expression, Indian Science Congress Association. Accordingly, in all places in the Draft Constitution wherever the expression Indian Science Congress Association has been used, my suggestion is to drop the word Association. I also find that you have used a new terminology to explain the organisation of the Congress. The existing terminology has worked quite well and I do not see any necessity for introducing any change. You may remember that at a meeting of the Council which was held in Madras, Dr. Howard suggested that the constitution should be as simple as possible and I fully agree with that remark. I think that some amplifications of the existing constitution will do quite well for the present. Your draft seems to be an extremely elaborate one but at the same time the existing constitution is a little too short. In the suggestions which follow, I have tried to come to a conclusion on the basis of the existing constitution and the Draft Constitution. Your appendix 2 deals with the work of the Sections. I do not know why you have brought this under appendix. So far as the actual work of the Congress is concerned, this portion is the most important one and accordingly it should be included in the constitution not in an appendix. If you like I shall be very glad to be present at a meeting of the drafting Committee to explain my points.

Yours Sincerely,
HEM CH. DAS GUPTA.

AMENDMENTS SUGGESTED.

Section 1.

Here delete the word Association.

Section 2.

The second object should be the holding of an annual meeting of the Congress.

Sections 3, 4, and 5.

I am in favour of the alternative sections 3, 4, and 5 as outlined at page 10 and the only change I would propose would be to have a class of Associate members who will pay an annual subscription of Rs. 5 as at present.

At pages 4-5 you have discussed the rights and privileges of members. In this section the rights and privileges of the ordinary members only have been discussed but nothing has been said of the life members, Session Members, Associate Members, and the student members. I beg to draw the attention of the Committee to this omission. The Associate members should enjoy the privileges which they now have.

Section 6.

In place of the word Council at page 11 I would propose the expression Executive Committee and hence the words 'that Committee' at the end of paragraph 4, page 11, should be replaced by the words, the General Committee.

As regards the Constitution of the Executive Committee (your Council) I would keep the existing rule No. III, only with the exception that there should be 5 members elected by the General Committee, and not 3.

I would like to keep the whole of the para. 2, of the alternative section 6 and the first two lines of the para. 3 while I would like to add an idea that the quorum for a meeting of the Executive Committee would be.

I am in full agreement with alternative (separately) section 6 dealing with the President and the General officers with this addition that each General Secretary shall hold office for 5 years from the date of his appointment but shall be eligible for reappointment and that so far as the General Treasurer and the General Secretary of the Asiatic Society are concerned the existing rule number VIII should be added as a rider. As regards the General Committee I would keep the existing rule No. II only with the addition of the word consecutive between the words 3 and meetings.

I am in full agreement with the functions of the General Committee as outlined at para. 4, page 14.

Section 7.

As regards the Council (or Advisory Board) I am in agreement with the proposal on page 6 with the alterations that the word 'two' between the words 'the' and 'preceding' should be deleted and the word 'ten other members appointed by the General Committee at its annual meeting' be added.

As regards the function of this Advisory Board or Council I am in agreement with two lines at page 6 and with all which have been outlined at page 15.

Sections 8 and 10.

I am in favour of the alternative Sections 8 and 10 with the deletion of the word Congress from the head-line.

The portion of Section 10 dealing with the Sections of the Congress should form along with the appendix 2 a separate section. This section should be called the Sectional Committee Section and I am of opinion that the rules for the Sectional Committees should be framed on the basis of the existing rules, as found in rules VI and XIV. I am, however, in agreement with the proposal of electing a Recorder for each section. The proposed Sectional Committee seems to be very big specially when we remember that all communications to the Sections have to be scrutinised by the Sectional Committee.

The last two paragraphs under section 10, page 9, should be kept as a separate section.

Section 11.

This section deals with the funds and finance. I think it is not impossible to amalgamate the two schemes as outlined in the Draft Constitution and come to some agreement.

Section 12.

As regards the amendments and new rules I would keep the existing rules XII and XIII.

The existing rule XV may now be looked upon as a bye-law and I would keep the whole of the section 9 regarding the bye-laws as given on pages 7 and 8.

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4. *Col. S. R. Christophers.*

CENTRAL RESEARCH INSTITUTE,
Kasauli, dated 6th April, 1929.

DEAR SIR,

With reference your letter dated January, 1929.

I have studied the draft constitution with the different alternative proposals and there appears to me no doubt but that the first draft is in every way to be preferred.

As it might be that some of the alternative proposals contained matter that it would be desirable to incorporate with the first draft I have made a comparison point by point of the rules as given in the first draft with those given in the alternative drafts but with the exception of an actual difference in policy as to the Council and General Committee, etc., most items seem to be covered by the first draft. I enclose an analysis statement that may be of assistance in such comparison.

Yours sincerely,
S. R. CHRISTOPHERS.

DR. S. P. AGHARKAR, M.A., Ph.D.,
General Secretary,
Indian Science Congress,
35, Ballygunge Circular Road,
Calcutta.

Analysis of proposals for Rules included in the first and Alternative Drafts.

Note: Clauses from the first draft are marked Orig. with the number of the Section in which they occur. Clauses from alternative drafts are marked Alt. with the number of the Section to which they are placed in the list of proposed rules. In the case of alternatives for Sect. 6 the clauses are marked Alt. (*a*), (*b*), and (*c*) respectively.

Brackets indicate that the proposal bracketed is for all practical purposes included in the first draft.

Title.

Orig. 1. No alternative suggestion.

Objects.

Orig. 2. Ditto.

Members.

Orig. 3. The Association shall consist of Ordinary Members and of such other classes of members as may be instituted from time to time.

Alt. 3, 4, and 5. The Association shall consist of (*a*) Life Members, (*b*) Ordinary Members, (*c*) Session Members, (*d*) Student Members and of such other classes of members as may be instituted from time to time.

The first seems preferable taken with the next entry and the framing of bye-laws regulating subscriptions, etc., given later in Orig. 3.

Orig. 3. Ordinary Members, who shall have compounded for the payment of all future annual subscriptions, shall be entitled Life Members.

Alt. 3, 4, and 5. [(*a*) Every Life Member shall pay, on admission, the sum of Rupees one hundred.]

The sum to be paid might be added if thought desirable by adding the words after subscription "by payment of the sum of Rupees one hundred". Or this might be covered by the byelaws covering subscriptions.

Definition of member.

Orig. 3. Ordinary Members (the number of whom shall be unlimited shall be those persons, etc. etc.

Alt. 3, 4, and 5. [(*b*) Ordinary Members (the number of whom shall be unlimited) shall pay, the sum of Rs. 10 on admission and the sum of Rs. 10 in every subsequent year.]

Qualifications for Ordinary Membership.

Orig. 3. No technical qualification shall be required for membership.

Alt. 3, 4, and 5. (No technical qualification shall be required on the part of an applicant for admission as a member of the Indian Science Congress Association:) but the Council is empowered, in the case of special circumstances arising, to impose suitable conditions and restrictions in this respect.

For decision whether qualifying clause desirable.

Orig. 3. Sex, race, nationality or creed shall be no bar to membership.

This might be considered as implicit in absence of any specified bar based on such grounds.

Privileges of membership.

Orig. 4. No alternative suggestions.

Infringement of rules and penalty.

Alt. 3, 4, and 5. Every person admitted as member shall conform to the rules and regulations of the Association, and for any infringement thereof shall be liable to exclusion by the Council, etc. etc.

No such clause in first draft. Doubtful if required.

Subscriptions.

Orig. 5. Ordinary members shall pay a subscription of ten Rupees provided always they shall be entitled at any time to compound for the payment of all future annual subscription by the single payment of a sum of Rupees one hundred.

Orig. 5. Subscriptions obligatory on other than ordinary members shall be prescribed by Bye-laws, etc.

Orig. 5. Annual subscriptions shall be due in advance on the first day of the financial year of the Association.

Alt. 3, 4, and 5. Subscriptions are payable at or before the Annual Meeting. Ordinary Members not attending the Annual Meeting may make payment at any time before the close of the financial year on June 30th of the following year.

The original draft seems much the simplest and best.

Membership (other than Ordinary Membership).

Orig. 3. It shall be competent to the Council at any time to institute classes of other than Ordinary Members provided always that the position of such classes of member and the circumstances, etc. etc.

Orig. 5. Subscriptions obligatory on other than ordinary members shall be prescribed in bye-laws concerning any such classes of members when instituted.

Alt. 3, 4, and 5. (*c*) Session Members, (whose numbers shall be unlimited) shall pay the sum of Rs. 10 on admission.

(*d*) Student Members, duly certified as bonâ fide students by the heads of their institutions, shall pay on admission, a sum of Rs. 2. Their numbers shall be unlimited and they shall not be entitled to any privileges beyond attendance at the Annual Meeting.

For decision.

General Meeting.

Orig. 8. The Association shall annually hold an Ordinary General Meeting which shall coincide with the Annual Congress, etc. etc.

No alternative suggestions.

Orig. 8. For Ordinary Members the right of attendance and voting at any General Meeting shall be limited to those who have completed two uninterrupted years of membership.

Orig. 8. At Special General Meetings of the Association twenty-five members shall form a quorum.

General Committee.

Alt. 3, 4, and 5. The Governing Body of the Association shall be a General Committee, shall be constituted as hereinafter set forth; and its affairs shall be directed by a Council and conducted by General Officers appointed by that Committee.

Alt. (*c*). The General Committee shall be constituted, etc. etc.

In the first draft the functions of this Committee are included in those of the Council. The first draft seems much the simplest and most effective organisation.

Council (quorum) at Meetings of the Council, three Members shall form a quorum.

Council (powers of).

Orig. 6. The direction and management of the affairs of the Association shall be vested in a Council.

Alt. (*a*). (The Council shall have the power to act, in the name and on behalf of the Association, in all matters which do not conflict with the functions of the General Committee.)

Orig. 6. The Council shall have power to fill all vacancies arising in their midst after the close of the Annual General Meeting.

Alt. (*a*). (In the intervals between two Annual Meetings, the Council shall manage the affairs of the Association and may fill up vacancies among General and other officers, until the next Annual Meeting.)

Alt. (*a*). (The Council shall have the power to appoint and dismiss such paid officers as may be necessary and to carry on the work of the Association, on such terms as they may from time to time determine.)

These would seem to be included in the two above clauses from the first draft.

Orig. 8. The Council may at any time convene a special General Meeting of the Association etc. etc.,

No alternative suggestions.

Council (Constitution of).

Orig. 8. The Council may submit any question to any special General Meeting, etc. etc.

No alternative suggestions.

Orig. 6. The Council shall consist of a President, a General Secretary, a Congress Secretary, the General Secretary of the Asiatic Society of Bengal for the time being, a Treasurer who shall be the Treasurer of the Asiatic Society of Bengal for the time being, the previous year's President, and three additional members.

Alt. (*b*) para. 2.

Alt. (*a*). The Council shall consist of Ex-Officio Members and of Ordinary Members elected annually by the General Committee, etc. etc.

Alternative proposal dependent on there being a General Committee.

Council (election of the officers).

Orig. 6 The President, the General Secretary and the Congress Secretary shall be nominated by the Council and these nominations shall be submitted for confirmation by a simple majority vote of the members voting at the Annual Meeting of the Association.

The three additional members shall be elected by a simple majority vote of the members voting at the Annual Meeting of the Association.

Alt. (*a*) 3. Procedure dependent on there being a General Committee.

Council (transfer of function). Provided under Alt. 6.—

Orig. 6. No alternative suggestions.

Council (rules for guidance of).

Alt. (*a*). The Council shall hold such meetings as they think fit, and shall in any case meet on the first day of the Annual Meeting, in order to complete and adopt the Annual Report and to consider other matters to be brought before the General Committee.

Alt. (*c*). The General Committee shall meet twice at least during every Annual Meeting.

No specification on these lines in first draft.

Officers. (President.)

Alt. (*b*). The President assumes office from the close of the Annual Meeting in which his nomination is confirmed by the General Committee. He shall deliver a Presidential Address at the next Annual Meeting at the conclusion of which meeting he **lays** down office.

Alt. (*b*). The President shall preside at all meetings of the Association and of its Council which he attends in his capacity as President. In his absence he shall be represented by one of the past presidents of the Association or by the Senior Sectional President present.

(General Secretary).

Orig. 6. The General Secretary of the Association shall be the Executive Officer of the Council for all affairs not directly regarding the Congress.

Alt. (*b*). (The General Secretaries shall control the General organisation and the general administration and shall be responsible to the General Committee for conducting correspondence and for the General routine work of the Association, excepting that which relates to finance and that which relates to the publication of Annual Proceedings.)

(Congress Secretary)

Orig. 6. The Congress Secretary of the Association shall be the Executive Officer of the Council for all affairs directly regarding the Congress.

Orig. 6. In cases of sudden vacation of office by the Congress Secretary of the Association, the General Secretary of the

Asiatic Society of Bengal for the time being shall immediately assume the former's duties and exercise his functions until the Council shall have appointed a new Congress Secretary.

No alternative suggestions.

Officers. (General rulings.)

Orig. 6. Last 5 paras. No alternative suggestions.

Alt. (*b*). It shall be competent for the General Officers to act, in the name of the Association, in any matter of urgency which in their judgment cannot be brought under the consideration of the Council; and they shall report such action to the Council at the next meeting.

Advisory Board.

Orig. 7. There shall be an Advisory Board which shall consist of the Members of Council, of the Past Presidents of the Association, resident or present in India, and of the Presidents of Sections of the Congress for the current and the two preceding years.

Alt. 7. (The Ex-officio members of the Advisory Board are the President of the Association, the President of each Station of the Annual Meeting, the General Secretaries, the General Treasurer and the Presidents of former years.)

An ordinary member of the Committee for each Section shall be nominated by the Committee of that Section. If the President of a Section be unable to attend, etc. etc.

Orig. 7. The Council shall consult the Advisory Board in matters of general policy and scientific importance.

Alt. 7. Every resolution on a scientific subject, etc. etc.

Every proposal for establishing a new Section, etc.

To be considered how detailed the points of consultation as laid down should be. How far is the Advisory Board of the alternative scheme becoming the General Committee of Alt. (*c*).

Alt. 7. The Advisory Board shall assemble, for the despatch of business, on the first day of the Annual Meeting, and, if necessary on the following day. Their report must be submitted to the General Committee on the last day of the Annual Meeting.

To be considered if desirable to add to first draft.

Bye-Laws.

Orig. 9. No alternative suggestions.

Preparations and Arrangements for Congress.

Orig. 10. The general preparations and arrangements for any Congress shall be left to the Council.

Orig. 10. The local preparations and arrangements for any Congress shall be left to a local Congress Committee.

Alt. 8 and 10. (The Local Committees and Sub-Committees shall undertake the local organisation, etc. etc.)

Orig. 10. The preparation, printing, publication, distribution, and sale of the Proceedings of the Congress shall be left to the Asiatic Society of Bengal.

Alt. (*b*). (The preparation, printing, publication, etc.)

Local Committee.

Orig. 10. The Local Congress Committee shall be appointed by the Council and shall after being appointed have power to co-opt members and to appoint its own officers other than secretaries, and sub-committees.

Alt. 8 and 10. [A Local Committee shall be formed to assist the General Officers (Congress Secretary) in making arrangements for the Annual Congress Meeting and shall have power to add to their number.]

Orig. 10. The local Congress Committee shall have a Secretary or Secretaries who shall be appointed by the Council.

Alt. 8 and 10. (The Council shall appoint, on the recommendation of the local Reception or Executive Committee for the ensuing Annual Meeting, a Local Treasurer or Treasurers, and two or more Local Congress Secretaries, etc, etc.)

Orig. 10. The local Congress Committee shall act in consultation and co-operation with the Council through the Congress Secretary.

Orig. 10. The Local Congress Committee shall amongst others make arrangements for the reception and entertainment of Members and for the distribution of papers and letters to Members during the Session of the Congress.

Sectional arrangements.

Orig. 10. The Congress shall be divided into Sections.

Orig. 10. The Congress Sections shall be managed by Sectional Committees.

Orig. 10. Each Sectional Committee shall nominate a candidate to be the Section's President in the next Congress and submit this nomination to the Council for consideration.

Orig. 10. The Council shall have power to fill any vacancies arising in Sectional Committees subsequent to their appointment and to replace the previous year's President of the Section by someone else in the case of the former vacating his Sectional Committee Membership.

Office administration when not in Congressional Session.

Orig. 10. The office administration of the Association when not in Congressional Session shall be left to the Asiatic Society of Bengal.

Funds and Finance.

Orig. II.

Alt. II, para. 2. The Accounts of the Association shall be audited annually by Auditors appointed by the General Committee (Council.)

Include in first draft if desirable.

Alt. (*b*) para. 3. The General Treasurer shall be responsible to the General Committee and Council for the financial administration of the Association.

Alt. II, paras. 1, 3, 4. Laying down powers and duties of the General Treasurer.

* For consideration as to inclusion in first draft.

Revision.

Orig. 12. The Association may add to, repeal or alter any part of this constitution in any Annual General Meeting of the Association, provided that three-fourths of the Members voting at such meeting, etc.

Alt. 12. Any alterations in the rules, and any amendments or new rules that may be proposed by the Council or individual members shall be notified to the General Committee on the first day of the Annual Meeting, and referred forthwith to the Committee of Recommendations, and on the report of that Committee shall be submitted for approval at the last meeting of the General Committee.

The first would seem the most desirable.

V. *Explanatory Notes.*

Individual members had of late years repeatedly urged the necessity of a permanent constitution for the Indian Science Congress. Up to the year 1924, when Rule XII, laying down a definite procedure for any change in the rules, was adopted by the General Committee, such views could *only* be expressed informally. Since then several changes have been made in the rules, but proposals for the formation of a permanent association to hold the Indian Science Congress (although informally discussed) have been held back in view of the financial dependance of the Indian Science Congress on the Asiatic Society of Bengal. The continuous increase in membership leading to a betterment of the finances of the Congress in recent years enabled members to raise this question again. Mr. Van Manen made certain proposals in this connection to the Council of the Indian Science Congress at its meeting held on the 4th January 1928 under the Chairmanship of Dr. J. L. Simonson. The Council considered these views and came to the conclusion that the time had arrived for the formation of a permanent organisation to conduct the work of the Indian Science Congress throughout the year. They appointed a Committee consisting of Dr. Baini Prashad, Mr. Johan van Manen, and Dr. S. P. Agharkar to draft a constitution with a direction to produce their report before the Madras meeting. In view of the decision certain members who had given notices of amendments to the Rules of the Congress agreed to withdraw them.

The drafting Committee held a preliminary discussion and in the consideration of the different views expressed asked Mr. Johan van Manen and Dr. Agharkar to prepare a draft. Owing to absence from Calcutta on tour, Dr. Baini Prashad was not able to take as much part in the preparation of the draft as was necessary.

The draft was considered by the Executive Committee at their meeting on the 14th December when Professor C. V. Raman, Dr. Baini Prashad, Lt.-Col. Sewell, Dr. P. Neogi, Mr. Van Manen, and Dr. S. P. Agharkar were present. The Committee resolved to recommit the draft to the drafting Committee for recasting in certain respects and to discuss the revised draft on the 20th December, 1928. Owing to the absence of several members from Calcutta it was decided by the members then present that the revised draft, together with the alternative proposals submitted by the undersigned, be printed and circulated to the members of the Indian Science Congress.

The Council at its meeting held on the 3rd January, 1929, considered these materials and resolved that the draft constitution, together with the existing set of rules, be circulated to the members of the Council, to elicit opinion, with a request that any remarks they might have to make, might be sent in to the General Secretary not later than the 31st March, 1929. The opinions of the members of the Council were considered at a special meeting of the Executive Committee held on the 14th August, 1929, and it was resolved to print and circulate these opinions among the members of the Council together with the recommendation, quoted at the beginning of this document.

In the preparation of the draft constitution legal opinion was taken on some points, and the rules and constitution of organisations like the British Association for the Advancement of Science, an association having very similar aims, were consulted.

S. P. AGHARKAR.

CALCUTTA,
5th December, 1929.

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1. The drafting of a constitution did not originate with Dr. Agharkar and Mr. Van Manen, nor was it performed by them in a private capacity.

Individual members had of late years repeatedly urged the question of a constitution on the General Secretaries of the Congress. Such representations have been numerous and insistent. The matter was brought to a head in the Calcutta session, 1928, when a number of private amendments to the present Rules were proposed. The consideration of these proposals was deferred after an undertaking by the Executive Committee to formulate a constitution which would render superfluous, the isolated proposals then brought forward. This matter was fully discussed in the meeting of Council of the Indian Science Congress held during the 15th Session, in Calcutta, on the 4th January, 1928, under the Chairmanship of Dr. J. L. Simonson, President of the Congress, and himself for 11 years a General Secretary to the Congress.

In this meeting, on the proposal of the previous year's President, Mr. Howard, a Committee consisting of Dr. Agharkar, Dr. Baini Prashad and the undersigned was charged with the task of formulating proposals to the Congress at its next session at Madras.

The members present during the final meeting of the Executive Committee called to discuss the matter, held on the 20th December, 1928, ultimately, by a formal resolution charged Dr. Agharkar and Mr. Van Manen, both members of that Committee, with the task of formulating the final draft.

In the 16th Madras session the matter was already one year old, now it is two years old.

2. The proposed name "Indian Science Congress Association" has nothing to do with any change of a presently existing name. The Congress itself would continue to be styled the Indian Science Congress, and its proceedings, the proceedings of such and such a number of the Indian Science Congress, as heretofore.

The so-called change in name is solely intended to enable by the use of some such word as "Association," the creation of a permanent organisation at the back of the Annual Congress, which is now non-existing. This organisation would ensure the necessary continuity of action and regularise such activities as are at present performed in an informal manner. This is in no sense a *change* of name of the *Congress*. Each session would still remain a session of the Indian Science Congress.

3. A Congress is a meeting which does not survive, once it has dispersed and its affairs have been liquidated. At present members are only enrolled for each specific Congress indicated by a serial number. There is no mechanism or terminology in connection with any permanent body.

At present there exists no permanent organisation for *holding* the Indian Science Congress. Each Indian Science Congress arises anew and then dies away. The word Association does not indicate an alteration of any existing name, but the creation of a body to give permanency to the Indian Science Congress, to connect the successive sessions, to provide a thread connecting the individual Congresses.

4. In practice this lack of permanency has already been found impracticable, and has led to such anomalies as for instance the one embodied in rule VII (second para) which lays down that each General Secretary shall hold office for five years. This can only be prescribed in connection with a surviving entity. At present that entity does not exist. At present no person can ensure a mechanical continuation of membership of future Congresses. He has each year to apply anew for membership. The *whole body* of membership for each specific Congress is created anew. Yet, in some indefinite way and in some respects, the Congress is practically regarded as a continuing entity. The whole *crux* of the matter lies in this contradiction.

5. The Congress is gradually accumulating funds and archives. These need an owner and responsible authority. That owner can only be a permanent organisation. At present that permanent organisation does not really or formally exist, though half of the activities of the Congress are based on a presumption *as if* it were existing.

6. The administration which is carried on throughout the year as to deal with an unbroken continuity of activities and responsibilities, always stretching over a period of three years, that of the previous, the current and the next sessions, each with their separate body of membership, and separate financial obligations.

The printer's bill for the congress proceedings of any one year cannot be paid for, or the copies be distributed, before the enrolment for the next Congress is already well under way. The finances of two congresses necessarily overlap. Nomination of the General President and the choice of the place of meeting are settled two years ahead.

7. It is for these reasons that the very development, expansion and success of the Congress demand some form of permanency for its organisation as a continuing body corporate. All that can be arrived at by the use of some such word as "Association" in addition to the words "Indian Science Congress," thereby introducing the possibility of a continuing instead of an annually newly created membership.

The Association would *hold* the Congress. At present each Congress *holds itself*.

8. Since 1922, the Proceedings of the Congress have expanded from a publication of 210 printed pages to one of over 500 printed pages and the Congress full membership has risen from a total of 440 in 1922 to one of 660 in 1929, not to speak of the increasing

number of previously non-existent Associate and Student Members.

9. What was possible by amicable and undefined arrangement in the beginning when, as in 1914, the total official expenditure of the Congress was Rs. 500/- with in all 100 members, may be entirely impracticable and undesirable when, as last year, the total official expenditure was over Rs. 15,000/- with 660 full members and about 225 Associate and Student Members.

10. The present rules are practically restricted to rules of procedure but do not establish the existence of a surviving body linking the separate Congresses. In other words, they do not, properly speaking, provide a constitution of any permanent body, if a constitution at all.

11. The problem, therefore, narrows itself down to the question whether there is a need, demand, or necessity to convert a series of isolated sessions of the Congress, which more or less informally inherit from their predecessors, into a series of organically connected sessions formally connected. This would mean the provision of a constitution, nothing more or less. All other questions depend on that question of principle and the main draft is only an attempt to formulate existing practice in the light of the experience of the last sixteen years, with a view to the adoption of such a constitution.

12. The measure of *need* and *necessity* would evidently be most clearly realised by the two officers for several years most closely in contact with the realities of the situation, namely the active General Secretary of the Congress and the General Secretary of the Asiatic Society of Bengal who is responsible for the general administration during the period of 51 weeks in the year that the Congress is not assembled in session.

The *demand* would depend on the measure of realisation of the difficulties by the general body of members, whose contact with the Congress is, more or less, limited to the actual session.

13. It may be added that though the original draft is only signed by the two officials who have been charged with its preparation, it is by no means the result of only their labours. A number of old members and officers of the Congress have been consulted whilst it was being drafted and the Statutes and Regulations of the British Association for the advancement of Science, an analogous body of ripe age, have been closely studied for guidance. Subsequently, it was considered in meetings of the Executive Committee. The leading principle adhered to in the drafting of the constitution as submitted has been the need for utmost simplification and flexibility.

14. The question is not only one of principle, but also a very practical one.

The greatest practical difficulty experienced by the administration under the present arrangements in the late enrolment of new members in consequence of the annual resurgence of the Congress.

15. Up to the beginning of October, this and last year, at most about a hundred members had been enrolled. The balance of over five hundred trickled in up to the very date of the beginning of the Congress, that is, up to the first days of January. With

the increasing numbers of members this causes an intolerable rush of work in the office just during the two most difficult periods of the year, the Bengal puja holidays in October and the Christmas holidays in December.

16. For the past seven years the office of the Asiatic Society of Bengal has had to devote a large part of these holidays with staff working extra time exclusively to deal with the incoming applications, with printing, and with correspondence, connected with the Congress.

17. The result is amongst other things that the prescriptions in the present Rules requiring the submission of papers to the Sectional Presidents before the 15th of October, is stultified.

More than half of the papers, sent in during late years, have been sent in by persons who, at the time of forwarding them, contrary to the rules prescribing that only full members may submit papers, were not as yet enrolled as members, and so entirely unauthorised to submit papers.

In the present year, on the 15th October, only 150 applications for membership in all had reached the office, which means that only that number of members would be authorised to submit papers.

18. The further result of these conditions has been that, with the increasing number of papers actually sent in, it has become almost impossible to prepare the abstracts in printed form for distribution before the meeting of the Congress. Of late years the Presidential addresses have been delayed to the last minute, and have had to be hurried by motor-car from the Press to the train to be personally conveyed by an obliging last member leaving Calcutta to attend the Congress. The press responsible for the work in connection with the Congress, notwithstanding its great resources in men and material, has given repeated, urgent, warning that under these conditions the arrangements may break down at any time.

19. The cause of these difficulties is the annual renewed application for membership and the defect can be remedied by the introduction of a continuing membership in a permanent association which would permit the completion and checking of its lists earlier in the year and consequently earlier administrative action in every direction.

20. The Congress does not simply run by itself. Like the issue of a newspaper, a theatrical performance or a session of parliament, the Congress shows in its annual meeting only a very brief spell of visible results which are the outcome of long preparatory action behind the scenes. With the present expansion of the Congress and its old dates of late enrolment and submission of papers (which dates are not even kept to), the time for preparation has become insufficient, and if no measures are taken to surmount this difficulty there is all reason to fear that the very success of the Congress may lead to a breakdown which would be a disaster and is to be avoided at all costs. The simplest and most natural way of meeting the difficulties seems to convert the Annual Congress into an activity of a permanent Association.

21. The present General Secretary of the Asiatic Society of Bengal has dealt with the general administration of the Congress

for a period of nearly half its existence and has seen through the press eight of its sixteen Proceedings. He has devoted considerable time, care, and labour to foster the success of the undertaking. He speaks in this matter with no less experience than genuine interest for the welfare and success of the movement.

22. If it be held that it is inopportune at this moment to solve the difficulties inherent in the present situation by the adoption of a constitution, which would meet the problems once for all, as an alternative the adoption might be suggested, of two simple measures which, though not dealing with the principles involved, would yet have great and far-reaching practical effect.

They would be the introduction of the following two rules, prescribing:—

(1) That the right to present papers to the Congress should be restricted to such full members only as have paid their subscription for the next Congress by the 1st of July of the preceding year.

(2) That no paper should be received for inclusion in the records of the next following Congress by a later date than the 15th of September.

23. The first rule would enable the drawing up in time of final member lists for use by the Sectional Committees who have to receive and judge the papers, and who are dependent on such lists for the acceptance of papers of Full Members. As it is, they regularly complain that the necessary information is not before them, as under the present circumstances it cannot be. Consequently there is no proper check in this matter.

24. The second rule would prevent congestion of work during the season of academical holidays in India in general and the Bengal puja season in particular, and also of irrevocable delay on account of these various holiday seasons, amongst which the Christmas holidays, closely before the session of the Congress, are most awkward.

25. Both rules together would go far to ensure the preparation of the printed abstracts in time for the Congress and largely minimise the danger of a breakdown in the very arduous arrangements to be completed before the meeting of the Congress takes place.

26. This year, even as late as the 12th of November, the copy of the abstracts of three sections had not yet been received, and the copy of only one of the ten Presidential Addresses had been received for composition by that date.

27. The Science Congress has expanded beyond anything that could have been foreseen in 1914. Its present danger is the adherance to the old unchanged dates and time-limits with the increased volume of preparatory work to be performed. The expansion of life needs a re-adjustment or form.

28. I have thought it helpful to place the above facts and considerations in detail before the body of members together with the other material, as a precise knowledge of the actual situation is indispensable for a true appreciation of the questions at issue.

CALCUTTA, JOHAN VAN MANEN.
5th December, 1929.

ACCOUNTS.

I.

Account of the Indian Science Congress for the year ending the 31st December, 1929.

RECEIPTS.				EXPENDITURE.			
Cr.				Dr.			
	Rs.	A.	P		Rs.	A.	P.
To Balance ..	17,845	15	5	By Printing ..	6,933	4	3
,, Contribution, Indian Institute of Science, Bangalore ..	300	0	0	,, Salaries ..	1,200	0	0
,, Contribution, A.S.B. ..	250	0	0	,, Indexing ..	155	0	0
,, Interest on Fixed Deposit ..	393	12	0	,, Travelling Expense ..	145	15	0
,, Subscriptions ..	6,714	8	0	,, Postage ..	671	3	6
,, Local Committee's Contribution of the balance of funds	500	0	0	,, Contingencies ..	205	11	6
,, Contingencies ..	11	12	0	,, Fixed Deposit with Imperial Bank ..	7,500	0	0
,, Return of advance by A.S.B.	5,000	0	0	,, Balance ..	16,704	13	2
,, Part return of Fixed Deposit by Imperial Bank ..	2,500	0	0				
TOTAL Rs. ..	33,515	15	5	TOTAL Rs. ..	33,515	15	5

Sd. K. C. MAHINDRA,
Honorary Treasurer,
Asiatic Society of Bengal.

II.

INDIAN SCIENCE CONGRESS, SESSION, 1930, ALLAHABAD.

Statement of Local Accounts.

Receipts and Payments account.

RECEIPTS.

	Rs.	A.	P.	Rs.	A.	P.
Government Grant ..				2,000	0	0
University Grant ..				1,500	0	0
Donations and Subscriptions of Membership of the Reception Committee ..				1,125	0	0
Sale of Membership Tickets ..				914	0	0
Sale of Excursion Tickets ..				375	0	0
Stall accommodation fee for Exhibition				104	0	0
Sale of Guide Book ..				1	0	0
Receipts of advertisement in Guide Book ..				74	0	0
Receipts from accommodation charges ..				249	14	9
Miscellaneous Receipts:—						
Sale proceeds of Materials	91	0	0			
Discount on Cheques	0	8	0			
				91	8	0
Carried over ..				6,434	6	9

EXPENDITURE.

	Rs.	A.	P.	Rs.	A.	P.
Stationery and Printing:—						
Stationery	23	13	6			
Printing	392	1	6			
				415	15	0
Guide Books ..				450	0	0
Postage and Telegrams:—						
Postage ..	60	1	6			
Telegrams	27	8	0			
				87	9	6
Bank Charges ..				2	12	0
Miscellaneous and Photo Charges:—						
Miscellaneous ..	78	0	3			
Photo Charges	39	0	0			
				117	0	3
Conveyance and Thela Charges ..				56	8	0
Labour Charges ..				66	13	0
Fire Insurance ..				60	0	0
Remittance to Calcutta Office ..				914	0	0
Excursion:—						
Motor, Lorry and Petrol Charges	707	0	0			
Hire of Boats	48	0	0			
				755	0	0
Musical Soiree ..				385	0	0
Hire of Furniture and Tents, etc. ..				1,112	0	0
Hire of Tents for European Camp ..				117	2	0
Carried over ..				4,539	11	9

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